Austin WATER

WATER FORWARD
INTEGRATED WATER RESOURCE PLAN

A WATER PLAN FOR THE NEXT 100 YEARS

austinwater.org

ACKNOWLEDGEMENTS

As a result of more than 3 years of effort, the Water Forward Integrated Water Resource Plan represents a transformational plan for Austin that will guide Austin's water future for the next century. The plan was prepared by Austin Water with support from the Water Forward Task Force, a consultant team, and the Austin community.

We express our appreciation to the many individuals and organizations that helped us build the Water Forward Plan. Your support and input shaped the plan to reflect our community's values. Thank you to those who took time out of their busy schedules to participate in community meetings and workshops, attend events, as well as provide input through surveys and other exercises both on-line and in person. Your input was thoughtful and reflected our community's passion and enthusiasm regarding water and its great importance to our lives and well-being.

This plan would not be possible without the collaboration and community input from participants throughout the plan development process. Sincerest appreciation goes to the Water Forward Task Force, which provided essential support for working through the plan development steps.

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

LIST OF ACRONYMS

Acronym	Definition
AC	Air conditioning
AEGB	Austin Energy Green Building
AF	Acre-foot
AFY	Acre-feet per year
AMI	Advanced metering infrastructure
ASR	Aquifer storage and recovery
AW	Austin Water
CII	Commercial, institutional, industrial
COA	City of Austin
COM	Commercial
DDM	Disaggregated demand model
DTI	Delphi, Trends and Imagine Austin
GIS	Geographic information system
GPCD	Gallons per capita day
IPR	Indirect potable reuse
IWRP	Integrated water resources plan
LCRA	Lower Colorado River Authority
MFR	Multi-family residential
MGD	Million gallons per day
PACE	Property Assessed Clean Energy
SFR	Single family residential
WAM	Water Availability Model
WHL	Wholesale customers
WTP	Water treatment plant
WWTP	Wastewater treatment plant

SECTION 1: EXECUTIVE SUMMARY

For more than 100 years, Austin Water has been committed to providing clean, safe, reliable, high quality, sustainable, and affordable water services to our customers. Austin's Water Forward Integrated Water Resource Plan will support that enduring commitment for the next 100 years and beyond. The Water Forward plan recommendations were developed using a holistic planning approach that balances multiple objectives such as water reliability, social, environmental, and economic benefits, and ease of implementation. The guiding principles of Water Forward, which helped inform these objectives and provided direction throughout the planning process, are listed to the right. The Water Forward Plan also sought to align with the Austin City Council's Strategic Outcomes related to Economic Opportunity and Affordability, Safety, Health and Environment, and Government That Works for All.

The recommendation to develop an integrated water resource plan emerged from the historic drought Central Texas endured from 2008-2016. During the drought, the lakes that supply Austin's drinking water fell to historically low levels. While Austin successfully weathered the drought, the event highlighted the need to increase the sustainability, reliability, and diversity of Austin's water supplies through an integrated water resource plan. Water Forward addresses these issues by modeling potential climate change effects on Austin's water supplies and evaluating multiple future scenarios to plan for droughts worse than what we have experienced in the past. The recommended plan is the culmination of a robust effort that involved the Austin community, the Water Forward Task Force, an outside consultant team, City staff, and others.

Water Forward recommended strategies include both major water supply projects and incremental solutions such as demand management or reuse. As Austin grows, new development can help to implement these demand management and reuse strategies to incrementally meet growing demands. The major water supply projects included in the plan are recommended largely to augment Austin's access to water during drought when our core surface water supplies are severely limited.

In a changing climate and growing community, there will always be uncertainty and risks to manage. The Water Forward plan recommendations will be implemented using an adaptive management approach, which means that we will be able to make adjustments to respond to changing conditions. Implementation of Water Forward recommendations will help Austin Water continue its commitment to providing clean, safe, reliable, and affordable water services to our customers.

WATER FORWARD GUIDING PRINCIPLES

Austin's Water Forward is a program to develop a long-term integrated water resources plan for the next 100 years. The following represents the plan's guiding principles:

- *Recognizing that Colorado River water is Austin's core supply, continue a strong partnership between the City and LCRA to assure its reliability*
- *Continue Austin's focus on water conservation and water use efficiency*
- *Strengthen long-term sustainability, reliability, and diversity of Austin's water supply through maximizing local water resources*
- *Avoid severe water shortages during times of drought*
- *Focus on projects that are technically, socially, and economically feasible*
- *Continue to protect Austin's natural environment, including source and receiving water quality*
- *Ensure Austin's water supply continues to meet/exceed all federal, state and local public health regulations*
- *Align with Imagine Austin's "Sustainably Manage Our Water Resources Priority Program"*
- *Maintain coordination and communication with regional partners*
- *Engage the public and stakeholders throughout the plan development process*

1.1 Need for an Integrated Water Resource Plan (IWRP)

Austin's continued population growth and development, the lessons of the historic 2008-2016 drought, and climate change pose challenges that require creative and robust solutions. An integrated water resource plan is an effective tool for planning how to address these challenges. The strength of this holistic planning method is that it allows the community to evaluate tradeoffs between potential solutions and to build solutions that achieve the most benefit in many objectives. To ensure that the plan reflects our community's values, the project team attended over 80 community events to gather feedback to inform the plan recommendations.

1.1.1 Population Growth

Austin has long been one of the fastest-growing cities in America. This growth is reflected in the Water Forward demand projections. Regional growth was also captured in river basin modeling that simulated future demands on the Colorado River and Highland Lakes. Water Forward includes conservation and supply strategies, including reuse, to meet the additional demand created by a growing City of Austin population. One of the ways to gauge the effectiveness of water conservation and reuse is to calculate how much water is used per person per day across the City, a measure known as gallons per capita per day (GPCD). **Figure 1-1** shows the projected Austin Water served population, customer demand, and calculated long-term average GPCDs assuming implementation of the recommended Water Forward strategies.

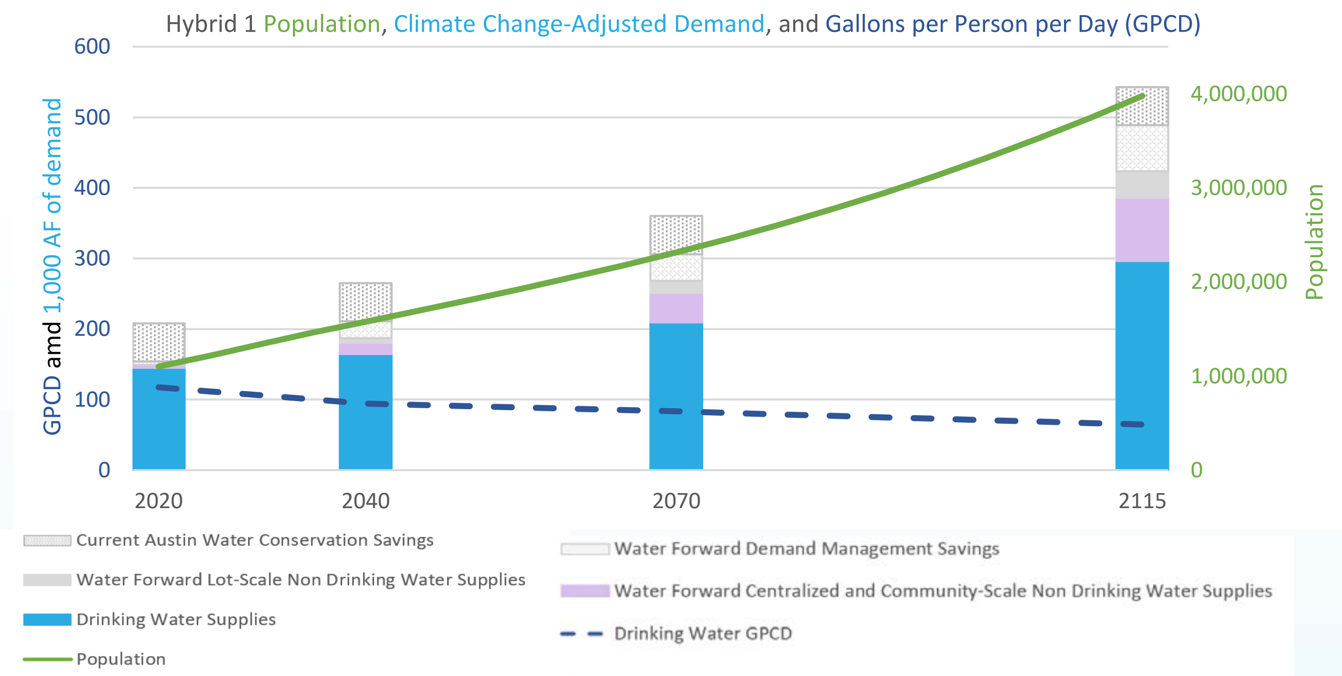


Figure 1-1. Population, Climate Change-Adjusted Demand, and GPCD for Water Forward Planning Horizons

The Water Forward plan was developed to meet needs identified through a preliminary analysis of current supplies and potential shortages. Potential future demand management and supply options were then combined to meet those identified needs. After determining the recommended plan strategies, the resulting GPCD amounts were calculated. The Water Forward plan was not developed to meet specific long-term average GPCD targets, but GPCD can be used to track progress in implementing plan strategies. When evaluating GPCDs, it is important to consider that divergence from projected population growth estimates and climate and weather variation, among other factors, can lead to differences in projected strategy yields, customer demands, and ultimately GPCDs. More information on GPCD as a metric can be found in **Section 9.3.2**.

1.1.2 Drought

During the historic 2008-2016 drought, Austin's water management portfolio was made up of its Colorado River and Highland Lakes supply, reclaimed water supply, conservation water savings, and drought contingency plan water savings. The drought caused storage in the Highland Lakes to drop to near-record lows and the inflows that we rely on to refill the lakes were lower than they had ever been. During the drought, Austin was evaluating a number of emergency strategies on an accelerated schedule. With Water Forward, Austin has taken the opportunity to proactively develop future demand management and supply strategies to avoid potential water shortages.

Figure 1-2. Lake Travis During the Historic 2008-2016 Drought

1.1.3 Climate Change

Climate scientists project that in the future the Austin region will see longer and deeper periods of drought punctuated by heavy rain events. Figure 1-3. illustrates the projected increase in temperature and changing precipitation in the Austin region, which will likely have profound impacts on flood and drought patterns. Water Forward evaluated multiple future scenarios which considered climate change effects and droughts worse than those experienced in the past to ensure reliability of the plan recommendations through a range of possible futures.

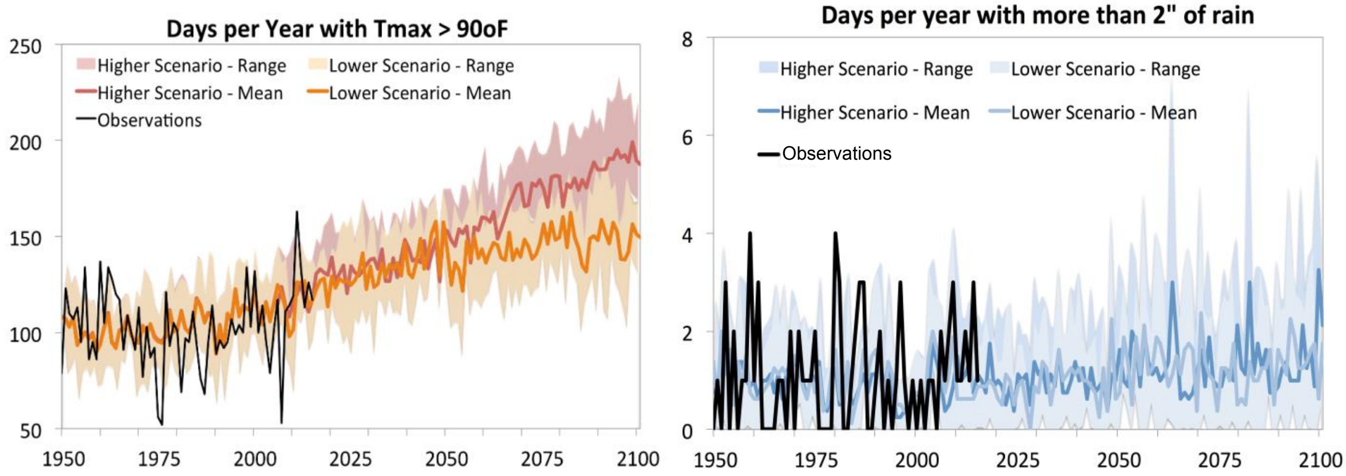


Figure 1-3. Projected Increase in Temperature and Changes in Precipitation in the Austin Region

1.2 Water Forward Recommendations

The Water Forward plan includes a robust set of strategies to conserve water and make our buildings and landscapes more water efficient. To help reduce leaks on the customer side, the plan recommends using Advanced Meter Infrastructure technology to alert customers to potential leaks and to help them manage their water consumption in close to real time. The plan also recommends reducing losses from pipes in the utility's water distribution system by enhancing Austin Water's current water loss reduction program.

The plan recommends the expansion of several existing Austin Water rebate programs, including programs to assist customers with the costs of "smart" controllers that help to make irrigation systems more efficient and current incentives to existing development to install water-efficient landscapes. The plan also recommends developing an ordinance to require water efficient landscapes for new single-family homes. To achieve efficient water use for many different types of development, the plan recommends developing benchmarks and water budgets that would initially encourage and eventually require customers to meet water usage targets.

Figure 1-4. Advanced Metering Infrastructure and Landscape Transformation

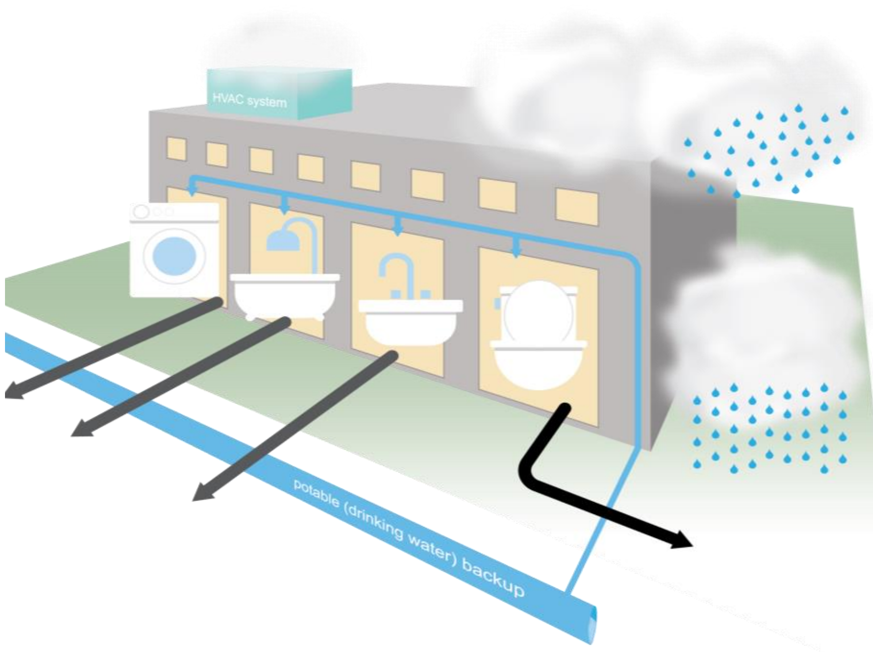


Figure 1-5. Alternative Water Sources Include Rainwater, Stormwater, Graywater, and Wastewater Reuse

The plan also includes strategies to make use of all water, including rainwater, stormwater, graywater, air conditioning condensate, and wastewater (typically called "alternative waters") that can be treated and reused to meet non-drinking water demands (see **Figure 1-6**). To do this, the plan recommends immediately beginning work to develop ordinances to require that new larger commercial and multifamily buildings install dual plumbing and use alternative water generated on-site or from the City's reclaimed water system for both indoor and outdoor non-drinking water purposes. Non-drinking water purposes include demands like toilet flushing and landscape irrigation.

To encourage existing development to use alternative water sources, the plan recommends additional enhancements to Austin Water's current rebate programs. The plan also recommends modifying what is currently in code to require more new developments to connect to the City's reclaimed water system and recommends expansion of the reclaimed water system to meet growing non-drinking water demands in the future.

Figure 1-6 Amount of Non-Drinking Water Demand Being Met by Non-Drinking Water Sources Over Time

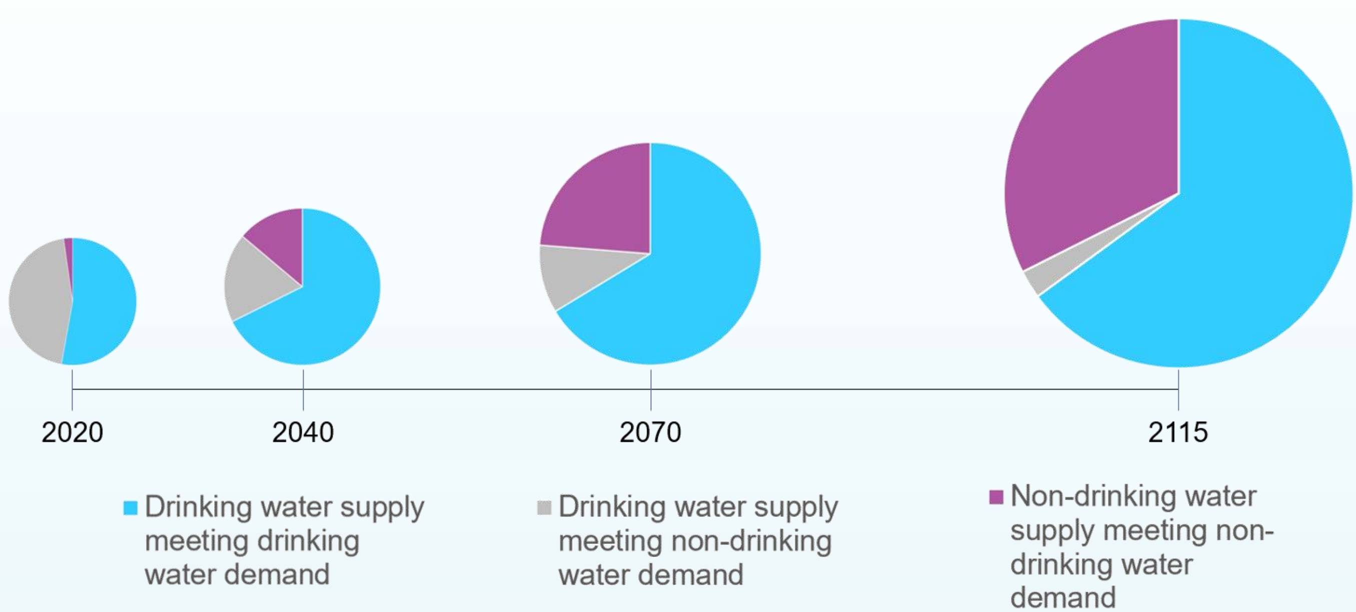
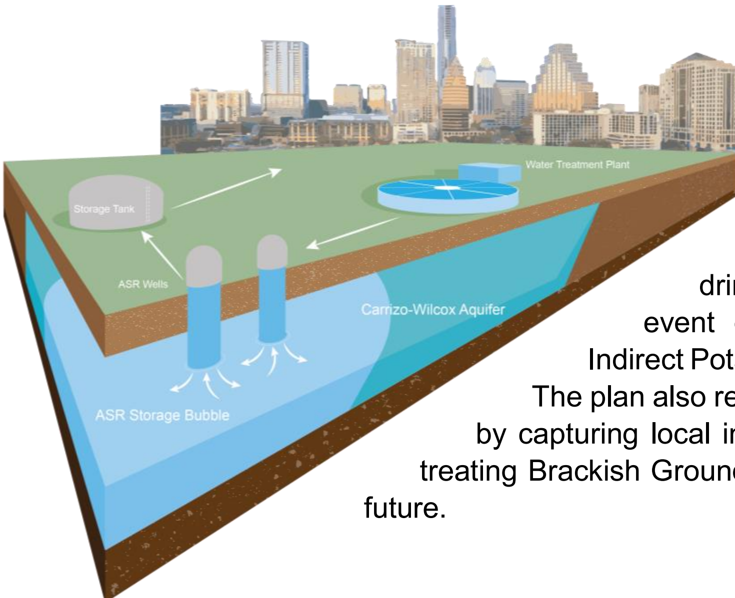
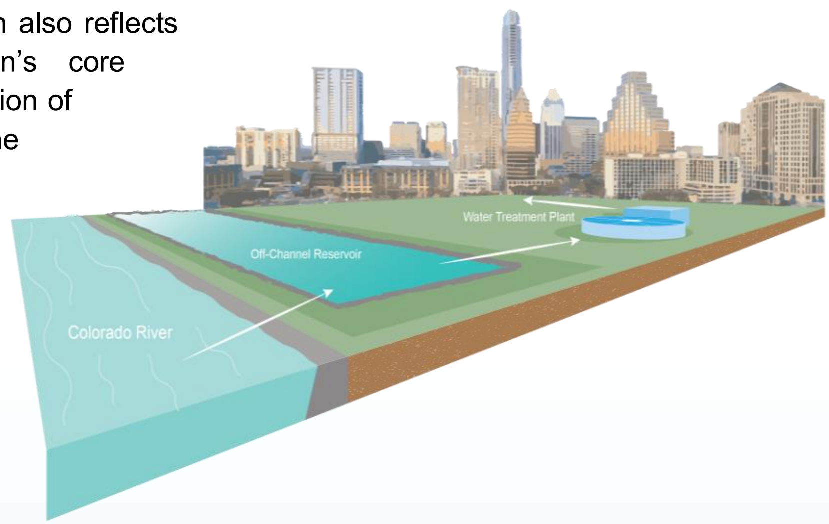


Figure 1-7. Aquifer Storage and Recovery



To see our community through future droughts, Water Forward recommends implementing storage strategies like Aquifer Storage and Recovery by 2040 and a new Off Channel Reservoir within the next fifty years. Storage strategies will allow Austin to store water available during wet times so that water can be retrieved and used to meet drinking water demands during dry times. In the event of a severe drought, the plan recommends Indirect Potable Reuse as a short-term emergency strategy. The plan also recommends the City bring on additional supplies by capturing local inflows to Lady Bird Lake in the near term and treating Brackish Groundwater to drinking water quality further into the future.

Figure 1-8. New Off Channel Reservoir

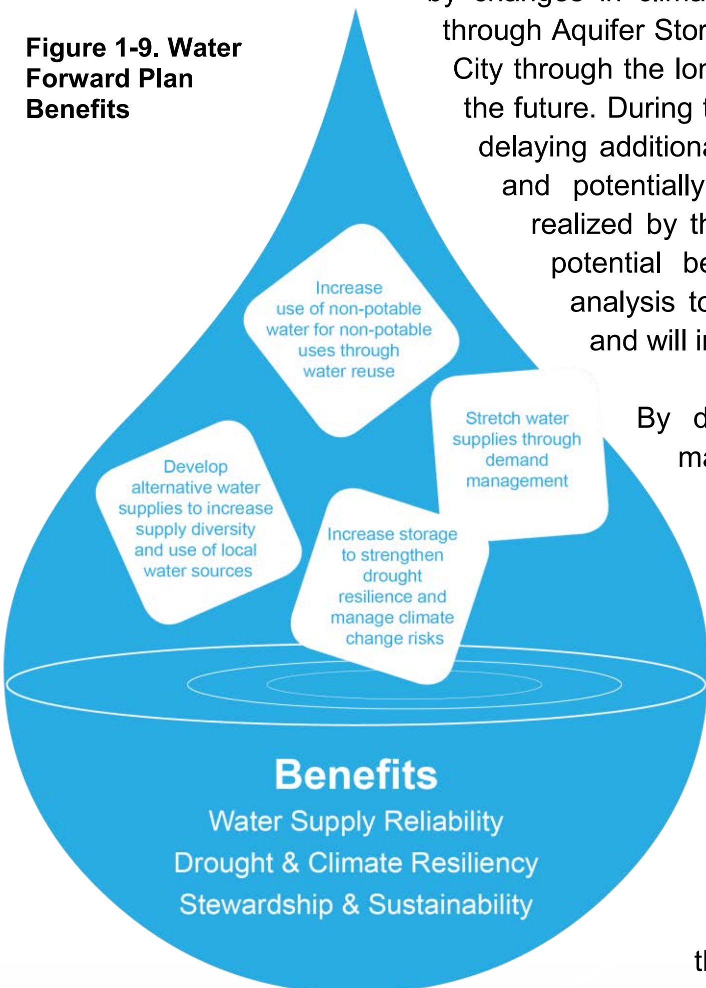


The Water Forward plan also reflects our continued commitment to Austin's core Colorado River supplies and implementation of best management practices. All of the Water Forward strategies are recommended as additions to Austin's current supplies, which include our core Colorado River supply, reclaimed water program, water conservation program, and drought contingency plan. As Austin's core supply, the City will continue to work with its regional partners to protect and enhance the Colorado River and Highland Lakes system supply.

1.3 Water Forward Plan Benefits

Implementation of the recommended Water Forward strategies will be transformative for the City of Austin and provide many benefits for our community (see **Figure 1-9.**). Water Forward's recommended strategies will help Austin stretch existing supplies by reducing overall demands, being more efficient with the water we do use, and expanding water reuse. Capturing and reusing water at the point of use increases our community's ability to access all local water sources and adds to supply diversity and resiliency. Expanding reuse supplies, whether at the building scale or from the City's reclaimed water system, allows us to use non-drinking water to meet demands that do not require drinking water quality. This "fit for purpose" approach offsets demand for drinking water supplies while providing a source of supply that is less affected

Figure 1-9. Water Forward Plan Benefits



by changes in climate. In addition, increasing water supply reserves through Aquifer Storage and Recovery will help to provide water to the City through the longer periods of drought that we may experience in the future. During the implementation phase, further benefits such as delaying additional payment for currently contracted water supplies and potentially delaying infrastructure improvements may be realized by the Water Forward strategies. The extent of these potential benefits will be explored through modelling and analysis to be performed in the plan implementation phase and will inform strategic deployment of the strategies.

By diversifying Austin's water supply and demand management portfolio, Water Forward increases the City's ability to maintain a reliable supply for the next 100 years. **Figure 1-10a** and **Figure 1-10b** show modeling results that illustrate how the strategies perform through a repeat of the historic 2008-2016 drought. **Figure 1-10a** shows that the identified needs are met if demands are set at projected 2020 levels and Water Forward strategies are implemented. **Figure 1-10b** shows that with the Water Forward strategies implemented, the City's demands are also met when demands are set at the higher projected 2115 levels. In **Figure 1-10c**, the drought that was simulated to mimic the 2008-2016 drought was made more severe to reflect potential climate change impacts. Using this simulation, with demands set at higher 2115 levels and with the Water Forward strategies implemented, a portion of the City's demands are met with a future regional supply source rather than Water Forward strategies. For the further-out planning horizons, planning to meet a portion of the City's future demands with a regional supply source was an intentional decision that reflects the uncertainty inherent in planning over a 100-year horizon. This reinforces the need to work with the City of Austin's partners in the Colorado River Basin to protect and enhance our future supplies, the results of which will be reflected in future plan updates.

Figure 1-10 Recommended Water Forward Strategies Modeled Through a Ten-Year Drought Sequence in Stationary and Climate Change Scenarios

1.4 Adaptive Management Plan and Implementation

Austin Water plans to begin the implementation process immediately after City Council approval of the Water Forward Plan. During the next five years Austin Water will take actions that are described in more detail in the sidebar. The Water Forward plan will be updated on a five- year cycle, using new data about changing conditions to inform potential adjustments to the planned implementation strategy and ensuring that we are on a path to meeting our goals.

The Water Forward plan is a high-level strategic plan intended to provide a roadmap to guide development of future programs, projects, and ordinances. The planning-level estimated costs to implement the recommended options through the 2040 planning horizon are presented in **Table 9-3**, and further detail can be found in **Appendix J – Options Characterization Sheets**. The estimated capital and operations and maintenance (O&M) costs presented reflect community costs, which include costs to be paid by Austin Water and its ratepayers, as well as costs to developers and program participants, with potential cost offsets though utility incentives. The costs are generally grouped into three categories. The cumulative capital cost planning-level estimates between 2019 and 2040 for the three categories are: current utility strategic initiatives in the capital plan—$614M, new utility strategies—$429M, and developer/program participant-owned strategies with potential cost offsets through utility incentives—$274M.

Cost and affordability were key community values communicated to the project team throughout the public input process for Water Forward. The recommended Hybrid 1 portfolio contains several conservation and reuse strategies, which help in stretching our existing supplies through delaying the cost of paying for water under our current municipal water supply contract or purchasing additional supply that would be needed every year. The cost of implementing the recommended strategies could be funded through, among other methods, Austin Water revenues, low-interest bonds or other outside funding, development costs, or shared community investments. In some cases, Austin Water investments could be combined with investments from the community, as in rebates and other incentive programs. Austin Water will work to determine what funding and resource requirements are most suitable to consider for implementing plan strategies and programs. More detailed

Major Water Forward Implementation Actions in the Next 5 Years

Ordinances (new or changes existing)

- *Develop alternative water ordinance for new larger commercial and multifamily development*
- *Develop dual plumbing ordinance for new larger commercial and multifamily development*
- *Expand current reclaimed water system connection requirements*
- *Develop ordinance to require submittal of water use information for new development*
- *Monitor existing ordinances related to air conditioning condensate reuse and cooling tower and steam boiler efficiency*

Incentives

- *Expand alternative water incentive program*
- *Expand landscape incentive program*
- *Expand irrigation efficiency incentive program*

Projects and Programs

- *Study and begin design, construction, and testing of an Aquifer Storage and Recovery pilot*
- *Implement Advanced Metering Infrastructure*
- *Enhance utility water loss reduction program*
- *Expand the centralized reclaimed water system*
- *Explore opportunities for community-scale decentralized reclaimed water systems*
- *Refinement of Indirect Potable Reuse emergency strategy*
- *Refinement of Capture Lady Bird Lake Inflows strategy*
- *Begin preliminary analyses to support five-year Water Forward plan update*

> **Social Equity and Affordability**
>
> *Water Forward began with the goal of conducting public outreach so that input from our community would equitably reflect the diversity of Austin's population and the utility's customers. The project team worked toward this goal through various means, including in-person outreach at community group meetings and online surveys and webcasts (see **Appendix A** for more information). Social equity was also included as a measure used to evaluate potential Water Forward strategies.*
>
> *During the implementation phase, social equity will continue to be a key consideration in the development of ordinances, incentive programs, and water supply projects. The implementation process will also include evaluation of ways to mitigate affordability impacts on ratepayers and residents. Public outreach efforts will continue during implementation to continue community dialogue and engagement.*

cost estimates and funding approaches for each recommended strategy will be developed in the implementation phase and will be subject to future Council action as required.

Implementing the Water Forward recommendations will require a thoughtful approach that protects public health, considers social equity, and maintains affordability and utility financial resilience. Austin Water is committed to implementing the Water Forward plan as quickly as possible, with appropriate time to hear from the community and develop implementation approaches that mitigate unintended consequences.

Future Water Forward efforts will continue the plan's emphasis on public outreach and community involvement. The plan recommends convening the Water Forward Task Force on a quarterly basis to support plan implementation efforts. With hard work and community support, implementation of Water Forward will create a more sustainable, reliable water supply for Austin for the next 100 years and beyond.

The recommended Water Forward strategies are presented in **Table 1-1.** Water Forward Recommended Strategies with Planning Horizon Yields and can generally be grouped into two categories: demand management options and supply options. Demand management options are strategies which reduce the demand on Austin's drinking water supply system, either by removing a demand (for example, transforming landscapes to require less water) or by offsetting drinking water demands (for example collecting rainwater to use for irrigation rather than drinking water). Certain demand management options, such as lot scale rainwater harvesting, were generally modeled to provide only the amount of yield that was needed to meet non-potable demands. Supply options are strategies which produce additional water to meet demands. This water includes strategies for drinking water supplies and non-drinking water supplies where appropriate. Supply options that are primarily for use during drought may not contribute yield on a year-to-year basis. In the table, "Estimated Yield" represents the target yields in each planning horizon. Actual yield from the Water Forward strategies will vary based on a number of factors depending on the type of option. Key factors include climate and weather variability, hydrology, and growth in population with subsequent growth in demand

Table 1-1. Water Forward Recommended Strategies with Planning Horizon Yields

Option #/ Type	Recommended Strategies	Average/ Drought	Estimated Yield (Acre Feet per Year)[1]			
			2020	2040	2070	2115
	Demand Management Strategies					
D1	Advanced Metering Infrastructure (AMI)	Both	600	3,880	5,770	9,370
D2	Utility Side Water Loss Control	Both	3,110	9,330	10,918	13,060
D3	Commercial, Industrial, and Institutional (CII) Ordinances	Both	1,060	1,060	1,060	1,060
D4	Water Use Benchmarking and Budgeting	Both	-	5,950	11,670	25,230
D5	Landscape Transformation Ordinance	Both	-	3,040	7,430	15,050
D6	Landscape Transformation Incentive	Both	-	320	630	930
D7	Irrigation Efficiency Incentive	Both	40	210	430	390
D8	Lot Scale Stormwater Harvesting	Both	-	330	870	2,280
D9	Lot Scale Rainwater Harvesting	Both	-	1,550	4,030	9,250
D10	Lot Scale Graywater Harvesting	Both	-	2,130	5,620	12,670
D11	Lot/Building Scale Wastewater Reuse	Both	-	1,320	3,670	7,880
D12	Air Conditioning (AC) Condensate Reuse	Both	100	1,080	2,710	5,150
	Demand Management Strategies Sub-Total	-	4,910	30,200	54,810	102,320
	Water Supply Strategies					
S1	Aquifer Storage and Recovery	Drought	-	60,000	60,000	90,000
S2	Brackish Groundwater Desalination	Both	-	-	5,000	16,000
S3	Direct Non-Potable Reuse (Centralized Reclaimed Water System)	Both	500	12,000	25,000	54,600
S1a	Indirect Potable Reuse (IPR) through Lady Bird Lake	Drought	-	11,000	20,000	20,000
S1b	Capture Local Inflows to Lady Bird Lake (infrastructure also included as part of IPR, above)	Average	-	3,000	3,000	3,000
S7	Off Channel Reservoir	Both	-	-	25,000	25,000
S9	Distributed Wastewater Reuse	Both	-	3,150	14,470	30,050
S10	Sewer Mining	Both	-	1,000	2,210	5,280
S11	Community Scale Stormwater Harvesting	Both	-	160	240	500
	Drought Supply Strategies	-	-	71,000	80,000	110,000
	Average/Both Supply Strategies	-	500	19,310	74,910	134,440
	Water Supply Strategies Sub-Total	-	500	90,310	154,910	244,440
	Water Forward Recommend Strategies Overall Total		5,410	120,510	209,720	346,750
	Water Forward Recommended Implementation Strategies to Realize Estimated Yields Above					
	Phase 1 and 2: Water Use Benchmarking and Budgeting Ordinance					
	Phase 1 and 2: Alternative Water Ordinance					
	Expansion of Alternative Water Incentive					
	Phase 1 and 2: Dual Plumbing Ordinance Development					
	Ordinance to Expand Existing Centralized Reclaimed Water Connection Requirements					
	Current Supplies and Conservation					
	Colorado River and Highland Lakes Supply	Both	325,000			
	Drought Contingency Plan	Drought	Varies			
	Austin Water Conservation Programs*	Both	54,320			
	Centralized Reclaimed Water System	Both	3,960			

***Note:** Austin Water conservation program savings were estimated based on savings calculated during 2012-2015

SECTION 2: INTRODUCTION

Central to Austin's economic vitality and high quality of life is a reliable, safe water supply. Currently, all the city's drinking water comes from the lower Colorado River system, which include Lakes Travis and Buchanan, the region's water supply reservoirs. In the future, the Colorado River system will likely experience climate change impacts, additional droughts, and future uncertainties. Coupled with rapid growth and economic development, these factors make future water planning more challenging than in the past.

Utilizing an adaptive management approach, this Integrated Water Resource Plan provides the essential strategic-level framework for Austin to meet these challenges and ensure a diversified, sustainable, and resilient water future, with strong emphasis on water conservation.

The City of Austin (the City) is the capital of the State of Texas and is located in the central part of the state. Central Texas falls within a transitional climate zone characterized by hot, humid summers and mild winter temperatures, with an average annual precipitation of 34 inches. There are numerous lakes, rivers, and waterways in the Austin area. The core water body in the region is the Colorado River. Austin sits just east of the 98th meridian, a geographical dividing line that currently represents a divide between areas that get more than 30 inches of rain annually and less than 30 inches annually. With climate change there is scientific concern that the divide between areas getting more than 30 inches of rain annually and less than 30 inches annually is shifting to the east.

The most recent drought, which occurred from approximately 2008 to 2016, was a historic drought and a key driver for the development of this Integrated Water Resource Plan. During the drought, inflows of water and combined storage volumes in Lakes Travis and Buchanan were at historic lows. The Austin community and others throughout the river basin responded to calls for water conservation as a way to extend supplies while the region was gripped by severe drought.

In the future, potential climate change effects, as projected by global climate modeling, are expected to result in increasing average and maximum monthly temperatures, and greater variability in precipitation—both of which will likely result in more frequent and longer-duration droughts[1]. With climate change it is also expected that wet periods will be more intense, meaning that it is anticipated that overall, dry periods will be hotter and drier and wet periods will be wetter.

[1] https://austintexas.gov/sites/default/files/files/Katherine_Hayhoe_Report_-_April_2014.pdf

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- *Ensure Austin's water supply continues to meet/exceed all federal, state and local public health regulations*
- *Align with Imagine Austin's "Sustainably Manage Our Water Resources Priority Program"*
- *Maintain coordination and communication with regional partners*
- *Engage the public and stakeholders throughout the plan development process*

During the recent historic drought, City Council convened Austin Water Resource Planning Task Force in April 2014 to evaluate the City's water needs, to examine and make recommendations regarding future water planning, and to evaluate potential water resource management scenarios for Council consideration. The Task Force was supported by Austin Water and Watershed Protection. The Austin Water Resource Planning Task Force Task Force convened its first meeting on May 5, 2014 and met intensively through June 25, 2014 to execute their charge. The Task Force's findings and recommendations are included in their July 2014 report to Council.

One of the key recommendations of the Austin Water Resource Planning Task Force was the development of an integrated water resource plan to evaluate the City's water needs, to examine and make recommendations on future water planning, and to evaluate potential water-resource management scenarios for Council consideration. On December 11th, 2014, City council passed a resolution (Resolution No. 20141211-119[2]) to create the Austin Integrated Water Resource Planning Community Task Force (referred to as the Water Forward Task Force) to support the development of the integrated water resource plan.

As summarized in **Section 3:**, throughout the collaborative and integrated Austin Water-led Water Forward effort, support for the integrated water resource plan development process was provided by the Water Forward Task Force, City staff from other departments, especially Watershed Protection Department, Office of Sustainability, and Austin Energy and outside consultant resources. Additionally, considerable input was received from our community through the Water Forward public engagement efforts. The recommended plan is the culmination of a robust effort which will support Austin Water's continued commitment to providing clean, safe, reliable, and affordable water services to our customers.

2.1 Water Forward IWRP Mission Statement

Austin Water is an industry leader in the delivery of water, wastewater, and recycled or reclaimed water services. As such, the City is taking a proactive step in developing its Water Forward IWRP which provides a high-level strategy document intended to provide information to decision-makers regarding the tradeoffs of future water resource investments, with a long-range viewpoint through a 2115 planning horizon. The IWRP evaluates water supply and demand management options with consideration of multiple planning objectives, and was developed using an open, participatory planning process. To guide the Water Forward process, Austin Water, in collaboration with the Water Forward Task Force, established a mission statement for the IWRP, as follows:

- The Integrated Water Resource Plan will provide a mid- and long-term evaluation of, and plan for, water supply and demand management options for the City of Austin in a regional water supply context.
- Through public outreach and coordination of efforts between City departments and the Austin Integrated Water Resource Planning Community Task Force (Task Force), the IWRP offers a holistic and inclusive approach to water resource planning.

[2] http://www.austintexas.gov/edims/document.cfm?id=223726

- The plan embraces an innovative and integrated water management process with the goal of ensuring a diversified, sustainable, and resilient water future, with strong emphasis on water conservation.

2.2 Overview of Austin's Water Supply System

For more than 100 years, Austin Water has been committed to providing clean, safe, reliable, high quality, sustainable, and affordable water services to our customers. Austin Water consistently ranks among the best in the country with regard to water quality. Austin Water owns and operates three major water treatment plants (WTPs)—Albert H. Ullrich WTP, Albert R. Davis WTP, and Berl L. Handcox, Sr. WTP—with a combined treatment capacity of 335 million gallons per day (MGD). Austin Water's water distribution system has over 3,900 miles of pipe and 21 major pump stations that deliver water to 9 major pressure zones. Austin Water also operates two major wastewater treatment plants (WWTPs)— South Austin Regional WWTP and Walnut Creek WWTP—which discharge treated effluent into the Colorado River. The combined treatment capacity of these two WWTPs is 150 MGD. In addition, the utility operates multiple smaller wastewater treatment plants throughout the area.

All of Austin's drinking water comes from the lower Colorado River. The lower Colorado River is generally known as the section of the river downstream of Lakes O.H. Ivie and Brownwood down to the Gulf of Mexico. The lower Colorado is dammed several times upstream from Austin, forming the Highland Lakes. Two of the Highland Lakes, Lake Buchanan and Lake Travis, act as the region's water supply and flood control reservoirs.

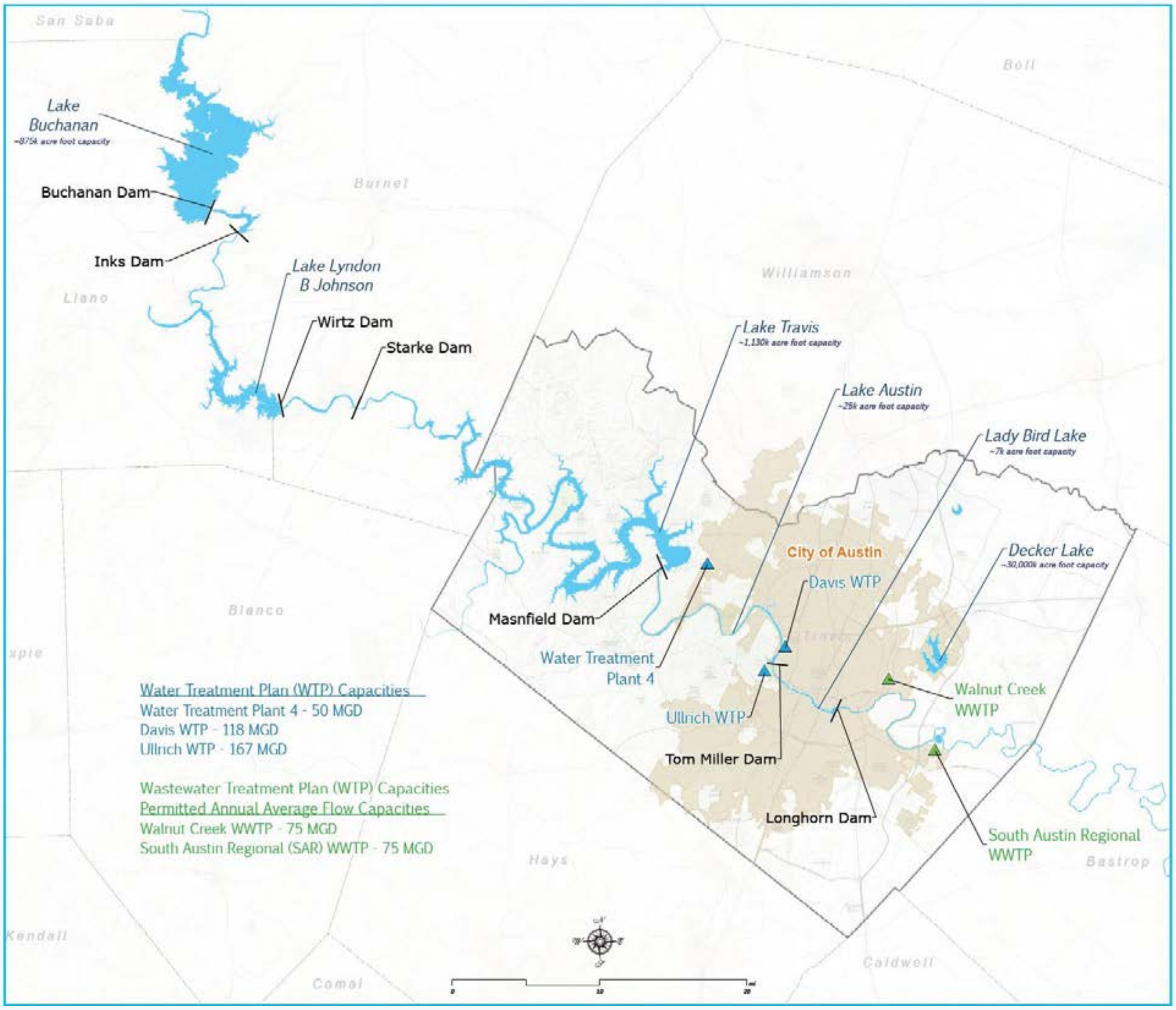
Water from the Colorado River and the Highland Lakes is available to the City through a combination of state-granted run-of-river water rights and a water supply contract with the Lower Colorado River Authority (LCRA) for firm water, which is water that is expected to be available without shortage through a repeat of the drought of record. The water supply contract began in October 1999, when Austin entered into a key water supply agreement with LCRA. This agreement was an amendment to a previous 1987 agreement and provides firm backup (including stored water from Lakes Travis and Buchanan) for Austin's run-of-river rights and additional firm water totaling up to a combined amount of 325,000 acre-feet per year (AFY). Under the 1999 agreement, Austin prepaid $100 million for supply reservation and use fees. Future water use payments to LCRA will be triggered when the annual average use for two consecutive calendar years exceeds 201,000 AFY. The year after this trigger is reached, Austin will begin paying for water diversion amounts above 150,000 AFY. The term of the 1999 agreement extends through the year 2050 with an option for the City to renew the agreement for an additional 50-year period through the year 2100.

The drought of record in the Lower Colorado River Basin was the 1950's drought for many decades. However, the recent historic drought in this basin (from approximately 2008 to 2016), has become the new critical period for water supply availability determination. Therefore, efforts by the LCRA, through its Water Management Plan, and the Lower Colorado Regional Water Planning Group (Region K) are currently underway to update firm water supply estimates for the Lower Colorado River basin with consideration of the recent drought. As these processes, which city staff are participating in, progress, additional information will become available to further quantify firm water supplies in the basin and evaluate the impact that the recent drought has had on firm water supplies.

Figure 2-1. illustrates the regional and local water supplies that currently provide drinking water for the Austin. Lakes Travis and Buchanan, the region's flood control and water supply lakes, can be found upstream of Austin in the figure. These lakes are managed by the LCRA, as is the entire lower Colorado

River system—from the watersheds flowing into Lake Buchanan, to Matagorda Bay on the Texas Coast. Lake Travis is formed by Mansfield Dam and Lake Buchanan by Buchanan Dam. Lake Austin and Lady Bird Lake, which are smaller lakes downstream of Lake Travis, are created by Tom Miller Dam and Longhorn Dam, respectively. Lake Travis and Buchanan vary in lake level and stored water volume depending on the amount of rain, inflow, evaporation, and lake system management including releases of water from the dams. In contrast, Lake Austin and Lady Bird Lake are much smaller and are typically operated at a relatively constant level.

Figure 2-1. Regional and City Water System



2.3 Water Supply Conditions and Drought

The availability of water under Austin's water rights and firm water supply contract with LCRA is generally dependent on rainfall, inflows to the storage reservoirs, and LCRA's management of the water stored in Lakes Travis and Buchanan. LCRA manages lakes Travis and Buchanan through a state-approved Water Management Plan, which was last updated in 2015. LCRA initiated another LCRA Water Management Plan update process in 2018.

The Austin area and the rest of Texas went through a historic drought from 2008 to 2016. During the drought the basin experienced the lowest annual inflows (i.e. water flowing into the lakes) since the late 1930's and early 1940's when the lakes were constructed. Prior to the recent historic drought, a drought that occurred in the 1950s was the drought benchmark for the Colorado River basin. Comparing the two droughts shows the greater severity of the recent drought, as the inflows from 2011 (the lowest annual inflow year from the recent drought) were 26% of the lowest annual inflows from the worst year from the 1950s drought. **Table 2-1** shows the lowest annual inflows on record, with years since 2006 highlighted in gray. Inflows from years occurring within the past 12 years make up eight of the top twelve lowest historical inflow years, including the top five.

Table 2-1. Top 12 Lowest Years of Historical Inflows

Rank	Year	Annual Total in Acre-Feet
1	2011	127,802
2	2014	207,642
3	2013	215,138
4	2008	284,462
5	2006	285,229
6	1963	392,589
7	2012	393,163
8	2017	429,959
9	1983	433,312
10	1999	448,162
11	2009	499,732
12	1950	501,926
Average Annual Total from1942 to 2017= 1,208,616 AF		

In addition to **Table 2-1.** Top 12 Lowest Years of Historical Inflows, another useful comparison to understand the magnitude of the recent drought is to compare the cumulative historical inflows of the recent drought to the cumulative inflow of the 1950's drought, which was the worst recorded drought experienced by the basin prior to 2008 (referred to as the drought of record). For this cumulative inflow comparison, models are used to adjust historical inflows from the 1950s drought to approximate inflows as if the new upstream reservoirs had existed in the 1950's drought. These model-adjusted inflows are referred to as "reference inflows". **Figure 2-2.** compares the cumulative historical inflow into lakes Travis and Buchanan for the recent hydrological drought from March 2008 - July 2016 to the cumulative "reference inflows" during the 1950's drought of record. While storm events in 2015 and the spring of 2016 significantly reduced the cumulative inflow difference, the total inflow since the beginning of the recent hydrological drought through June 2018 is still below that of the 1950s drought.

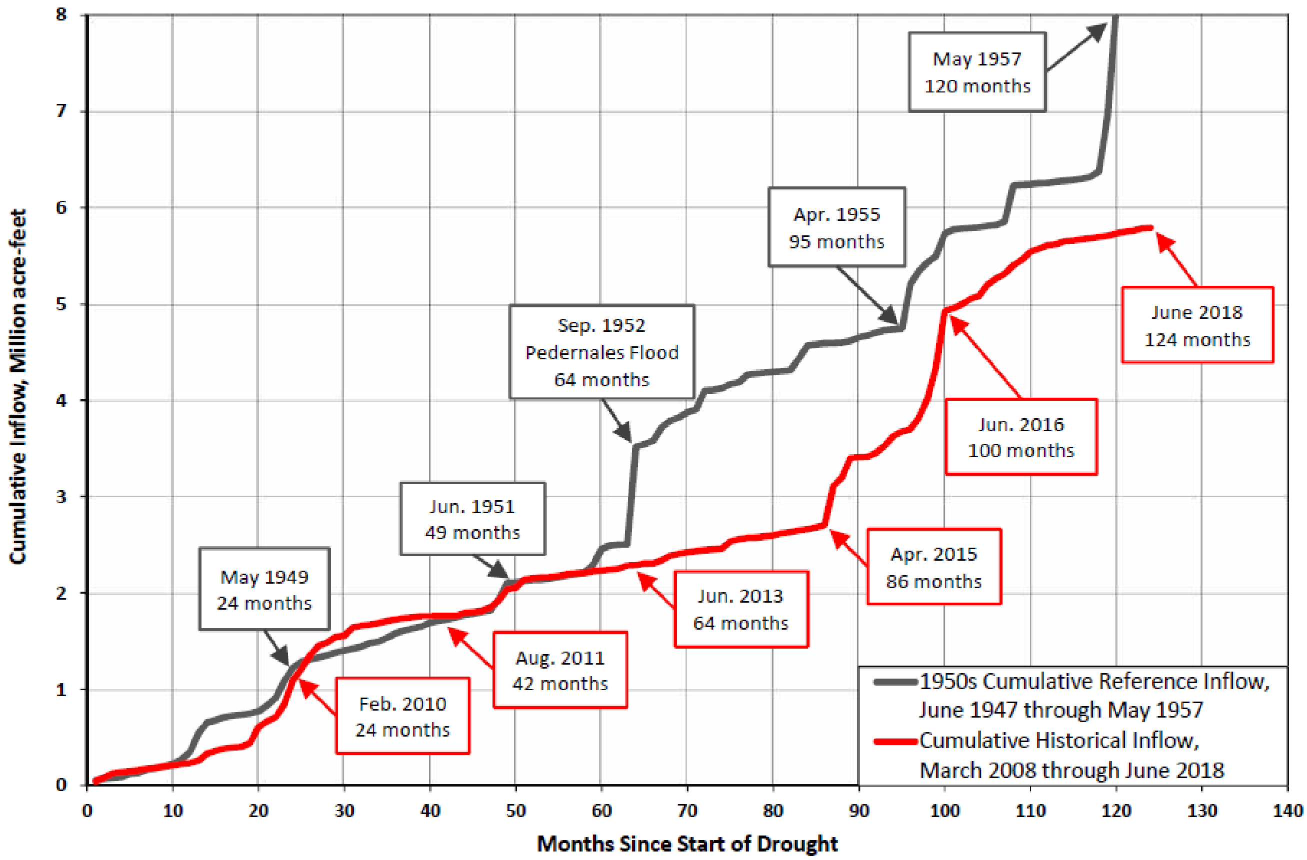


Figure 2-2. Cumulative Inflows to Lakes Buchanan and Travis; 1950's versus Recent Drought

Storm events in 2015 and 2016 significantly increased combined storage of lakes Buchanan and Travis, reaching full levels in April 2016 for the first time since 2008. As shown in **Figure 2-2.** Cumulative Inflows to Lakes Buchanan and Travis; 1950's versus Recent Drought**,** the combined stored water volume in Lakes Travis and Buchanan dropped to 637,123 acre-feet on September 19, 2013, which is 32% of the total combined storage volume. That amount is second only to the minimum in the 1947-1957 drought, which caused the lakes to drop to a record low of 621,221 acre-feet of total combined storage, which is 31% of full.

As can be seen in **Figure 2-3.**, the Lower Colorado River Authority released large volumes of water from Lake Travis and Buchanan for downstream rice irrigation operations in the lower three counties in the Colorado River basin. In 2011, the Lower Colorado River Authority released 433,251 AF from Lakes Travis and Buchanan for agricultural irrigation. For comparison, that year, the City's municipal use, under its agreement with LCRA, was 168,334 AF, including 61,712 acre-feet diverted under Austin's water right from the Colorado River and 106,622 AF obtained from stored water in lakes Travis and Buchanan. Also, for comparison, in 2017, Austin used approximately 149,000 AF for municipal purposes. In 2011, an estimated 192,404 acre-feet evaporated from the six Highland Lakes (Buchanan, Inks, LBJ, Marble Falls, Travis, and Austin).

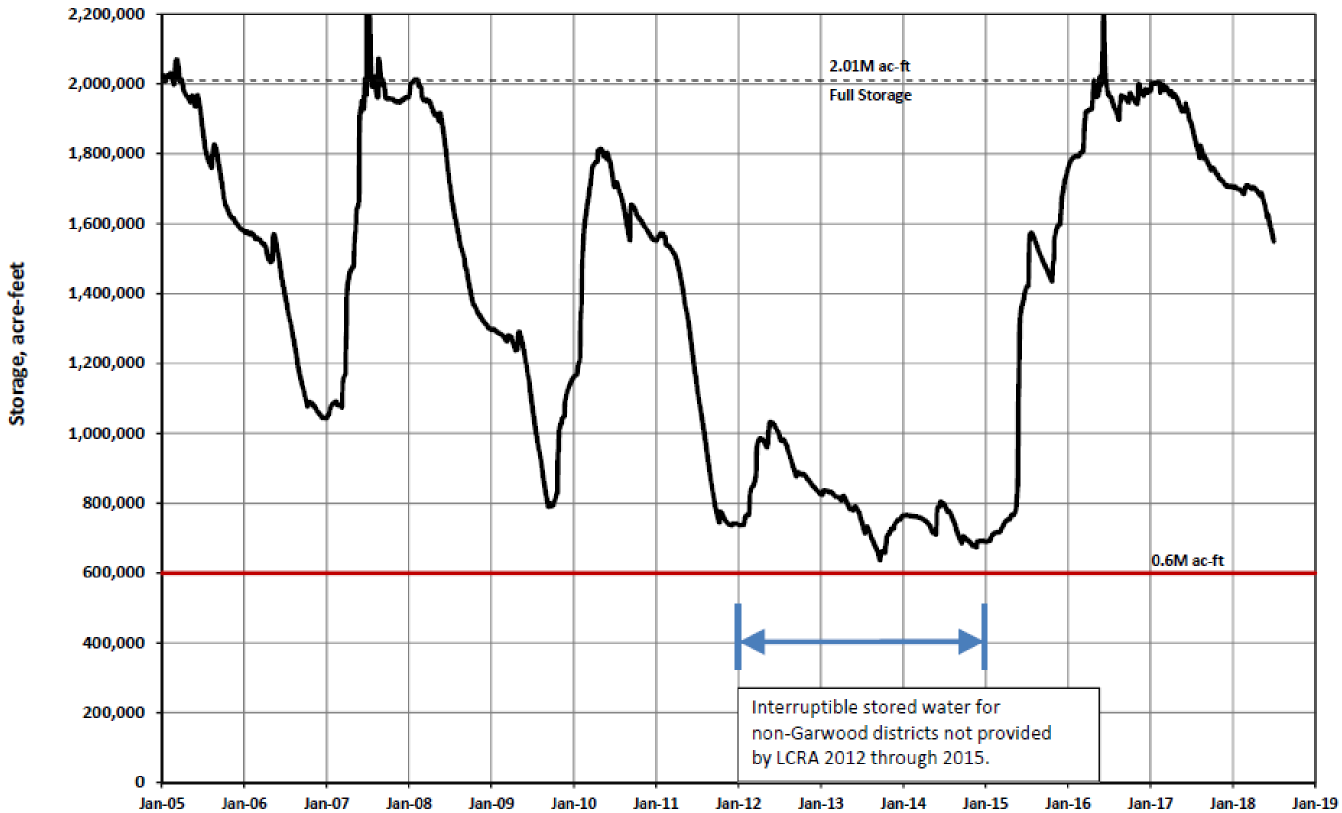


Figure 2-3. Combined Storage of Lakes Buchanan and Travis from January 2005 - July 2018

After the large agricultural irrigation releases from lakes Buchanan and Travis in 2011, the Lower Colorado River Authority sought and received approval by the Texas Commission on Environmental Quality Emergency Orders for 2012, 2013, 2014, and 2015 to depart from operating under the Lower Colorado River Authority Water Management Plan that was in effect during that time. Concurrent with the drought and the Texas Commission on Environmental Quality emergency order process, LCRA's Water Management Plan was revised.

The Lower Colorado River Authority's operations and management of the water stored in lakes Travis and Buchanan is guided by the Lower Colorado River Authority Water Management Plan, a document approved by the Texas Commission on Environmental Quality. In November 2015, Texas Commission on Environmental Quality approved an updated Water Management Plan that governed the Lower Colorado River Authority's operation of the lakes since the 2016 crop season which started in March. The updated plan better protects the water supply for firm customers, including City of Austin, and allows the Lower Colorado River Authority to more quickly adapt its operations as drought conditions change. Revisions include incorporating procedures for curtailing interruptible water such that combined storage in Lakes Travis and Buchanan is maintained above 600,000 AF through a repeat of historic hydrology through 2013. The revised plan also incorporates a three-tier regime that considers inflows, current storage, and modeled future storage conditions in determining water availability given to interruptible agricultural customers. Additionally, availability of interruptible stored water will be determined separately for each of the two crop seasons, rather than having the determination made once for both crop seasons, as was the case in the previous Water Management Plan. The revised Water Management Plan also places volumetric limits on interruptible stored water that may be released.

With more than a century of reliance and investment, Austin's core supply and infrastructure systems are centered on the Colorado River supply. Austin has senior water rights and firm water supply agreements with LCRA that provide Austin with firm water supplies of up to 325,000 AF per year. Therefore, protection of Colorado River system firm water interests is critical.

Throughout the drought, City of Austin representatives worked diligently through the critical LCRA Water Management Plan revision and Texas Commission on Environmental Quality Emergency Order processes to proactively ensure reservoir management of Lakes Travis and Buchanan is consistent with Austin's firm water interests and with LCRA's lake permit duties and firm customer agreements. LCRA Is again revising its Water Management Plan. As part of the approval process for the 2015 LCRA Water Management Plan, a Texas Commission on Environmental Quality ordering provision specified that LCRA would begin an update process in January 2018. The basin naturalized hydrology has been extended through 2016. Austin is participating in this important process and will plan to participate in all future similar processes.

LCRA's Water Management Plan requires pro rata curtailment of 20% for firm water customers if the LCRA Board declares a Drought Worse than the Drought of Record. Preparation for potential implementation of pro rata curtailment in the recent historic drought included a process whereby firm customers, like Austin, could receive credit from LCRA for certain verified water savings from conservation efforts in determining pro rata allotments. The criteria for determining a Drought Worse than the Drought of Record are included in the LCRA Water Management Plan and involve drought duration, intensity, and storage volume (triggered at 600,000 acre-feet or 30% of capacity, a level the combined storage has never reached).

During the recent historic drought, a 2014 Austin Water Resource Planning Task Force was convened by the Austin City Council. This 2014 Task Force was charged with: (1) evaluating the city's water needs; (2) examining and making recommendations regarding future water planning; and (3) evaluating potential water resource management scenarios for council consideration. A key recommendation of the 2014 Task Force was the development of an Integrated Water Resources Plan (IWRP). Austin's Water Forward effort, which began in early 2015, is the process to develop the IWRP.

2.4 Sustainable Water Resource Management Efforts

Austin Water has a long history of sustainable water management. As outlined in **Section 6:**, Austin's Water Conservation Program is recognized as an industry leader. Austin also has a reclaimed water system with a growing customer base. Austin Water consistently meets or exceeds state and federal requirements for water quality including drinking water quality standards and treated wastewater discharge standards.

Austin Water actively manages thousands of acres of land, including the Balcones Canyonlands Preserve and Water Quality Protection Lands. Through its Wildland Conservation Division, Austin Water manages approximately 28,000 acres of Water Quality Protection Lands and approximately 14,000 acres of Balcones Canyonland Preserve endangered species habitat land.

In 2017 Austin joined the Water Utility Climate Alliance, a leader in the sustainable water resource management field and currently in its tenth year. The Water Utility Climate Alliance provides a forum for utilities to exchange experiences about climate challenges how utilities are working to meet those challenges. Austin Water is a member of the US Water Alliance, which hosts an annual One Water Summit, which provides a forum for exploring sustainable water. The Austin Delegation participated in the One

Water Summit in New Orleans, Louisiana in 2017 and in the Twin Cities, Minnesota in 2018. Through internal staff efforts, coordination with other City departments, development of the Water Forward integrated water resource plan, and participation with various organizations, Austin Water explores on-site, centralized, and decentralized use of alternative water sources, innovative water strategies, and concepts like net zero and net blue on an ongoing basis.

Austin's Watershed Protection Department has a long history of water quality protection and sustainable water resource management through reducing the impact of flood, erosion, and water pollution. Watershed Protection has been leading efforts to develop green stormwater infrastructure projects, guidance, and proposed ordinance requirements. These efforts have been coordinated with Austin Water and others to explore opportunities to gain multiple beneficial uses of stormwater management strategies. These ongoing efforts are in harmony with Imagine Austin, which includes comprehensive guidance on sustainable management of Austin's water resources. Imagine Austin encourages use of green infrastructure to protect environmentally sensitive areas and integrate nature into the city.

Both Austin Water and Watershed Protection Department co-lead Imagine Austin's Sustainably Manage Our Water Resource Priority Program. Through these efforts, Austin Water and Watershed Protection Department coordinate on water resource management efforts from the local to regional scale. The work of this priority program has supported efforts to respond to challenges posed by a changing climate, major flooding, drought, population growth, and other factors that require adaptation and increased planning and coordination. Strengthened communication and coordination between Austin Water, Watershed Protection, and other partner departments over the past six years has been beneficial since the adoption of Imagine Austin in 2012 and its creation of the priority program. More information on Imagine Austin's Sustainable Manage Our Water Response Priority Program can be found at https://www.austintexas.gov/page/sustainablewater.

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SECTION 3: COLLABORATIVE PLAN DEVELOPMENT PROCESS

Water Forward is an integrated water resources planning process used to evaluate potential water supply and demand management options and develop a plan that is representative of Austin community values. This section describes the overall Water Forward process from development of objectives and performance measures, to option screening and characterization, through to portfolio development and evaluation. This section also summarizes the outcome of efforts to gather meaningful public input to inform each stage of the plan development process.

AT A GLANCE

- *Task Force Involvement*
- *Project Scoping and Team*
- *Public Engagement*
- *Evaluation Process Overview*
- *Plan Objectives and Performance Measures*
- *Options Screening and Characterization*
- *Portfolio Development and Evaluation*

3.1 Task Force Involvement

In 2014, the Austin Water Resource Planning Task Force was convened during the height of the 2008 to 2016 drought and tasked with analyzing the City's water needs and making recommendations on how to augment the City's future water supply (see Resolution No. 20140410-033). On July 10, 2014, the Austin Water Resources Planning Task Force presented their recommendations to the Austin City Council which included recommendations on demand management and water supply strategies. This IWRP was a foremost recommendation of the 2014 Austin Water Resource Planning Task Force.

The Austin Integrated Water Resources Planning Community Task Force was created to support the development of the IWRP (see Resolution No. 20141211-119). The Mayor and Council-appointed Task Force members are shown below:

- Sharlene Leurig (Chair)
  District 4 - Council Member Casar
- Jennifer Walker (Vice-Chair)
  District 9 - Mayor Pro Tem Tovo
- Bill Moriarty
  Mayor Adler
- Clint Dawson
  District 1 - Council Member Houston
- Sarah Richards
  District 2 - Council Member Garza
- Perry Lorenz
  District 3 - Council Member Renteria
- Lauren Ross
  District 5 - Council Member Kitchen
- Todd Bartee
  District 6 - Council Member Flannigan
- Robert Mace
  District 7 - Council Member Pool
- Marianne Dwight
  District 8 - Council Member Troxclair
- Diane Kennedy
  District 10 - Council Member Alter

The Task Force also included Ex Officio members from several City of Austin departments.

- **Austin Water**
  Greg Meszaros, Director
- **Austin Energy**
  Kathleen Garrett, Director of Environmental Services
- **Austin Resource Recovery**
  Sam Angoori, Director
- **Neighborhood Housing and Community Development**
  Josh Rudow, Planner Senior
- **Office of Innovation**
  Kerry O'Connor, Chief Innovation Officer
- **Office of Sustainability**
  Lucia Athens, Chief Sustainability Officer
- **Parks and Recreation**
  Sara Hensley, Interim Assistant City Manager
- **Watershed Protection**
  Chris Herrington, Supervising Engineer

The Task Force played an instrumental role in shaping the development of the Water Forward Process, providing input along the way to shape the planning process and recommendations that are included in the plan. Task Force meetings were held on a generally monthly basis from May 2015 through October 2018. To view agendas, approved minutes and supporting documents, please visit: http://austintexas.gov/cityclerk/boards_commissions/meetings/132_1.htm.

3.2 Project Scoping and Team

Austin Water, with input from the Water Forward Task Force, conducted extensive research in developing the scope of work for the plan's development. Additionally, through monthly Water Forward Task Force meetings, among many other relevant topics, information from other cities involved in similar processes was presented and discussed. Additional preparation work included conducting a Water Conservation Study[3] through the Office of Sustainability.

After this groundwork had been laid and the scope of work had been developed, the City conducted a Request for Qualifications-based procurement process for selecting a consulting firm team to support development of the plan. The CDM Smith team, including a number of sub-consultants, was selected through this process as the main consultant team. CDM Smith has direct experience in developing integrated water resource plans for large municipalities, including the Los Angeles Integrated Resources Plan and Long-Range Water Resources Plan for the San Diego Public Utilities Department. CDM Smith's team included GHD, a firm based in Australia with experience in developing the City of Sydney Decentralized Water Master Plan and Development of an Alternative Water Atlas across Melbourne.

In addition to the main consultant team for the IWRP development, Austin Water contracted with Climate Scientist Dr. Katharine Hayhoe (ATMOS Research and Consulting) to develop forecast data to incorporate planning for climate change impacts on basin hydrology into the IWRP. Dr. Hayhoe is a professor in the Department of Political Science and Director of the Climate Science Center at Texas Tech University and a well-known authority on climate change. Consultant resources for the plan development also includes Consulting Hydrologist Dr. Richard Hoffpauir, P.E. (Hoffpauir Consulting) to perform river system water

[3] Water Conservation Study, September 30, 2015, prepared by Maddaus Water Management, Inc, for City of Austin, Office of Sustainability, and Austin Water Utility. Posted in Austin Integrated Water Resource Planning Community Task Force regular meeting materials from October 6, 2015: http://www.austintexas.gov/edims/document.cfm?id=240290

availability modeling (WAM) analyses to evaluate water supply needs and supply and demand management portfolios. Dr. Hoffpauir is considered an expert in WAM modeling. These consultant resource teams worked in collaboration with Austin Water staff and made numerous presentations to the Water Forward Task Force.

In addition to the consulting team, numerous city staff members were involved in developing the plan and information that supported plan development. Austin Water staff led the effort with support from staff from Watershed Protection Department, Austin Energy, Office of Sustainability, and others.

3.3 Public Engagement

Public outreach and education efforts for the IWRP gathered meaningful public input used to develop a plan that is representative of Austin community values. Information on how input was used at key decision points is included in subsequent portions of this section. Water Forward's public involvement sought to address the following core goals, which were identified in the initial Water Forward Public Outreach Framework (see **Appendix A** for more details):

- **Community Values** – Identify community values that should be reflected in the IWRP.
- **Diverse Public Input** – Seek input from the community which reflect the diversity of Austin's population and customers.
- **Public Education** – Inform and educate the community throughout the plan development process.

Since 2016, Austin Water has collected public input through over 80 outreach events, including five Water Forward Public Workshops, four Targeted Stakeholder Meetings, and 10 Summer Series events (one in each City Council district). Austin Water has delivered presentations and/or outreach materials at more than 60 community events, information sharing sessions, community group meetings, seminars/professional events, and district town halls. The input received has been considered throughout the process of developing the plan and preparing the Draft Water Forward Plan Recommendations.

A summary of all 80 outreach activities and more detailed information on public outreach efforts is included in **Appendix A**. A map showing the location of outreach activities through May 2018 is presented in **Figure 3-1.**.

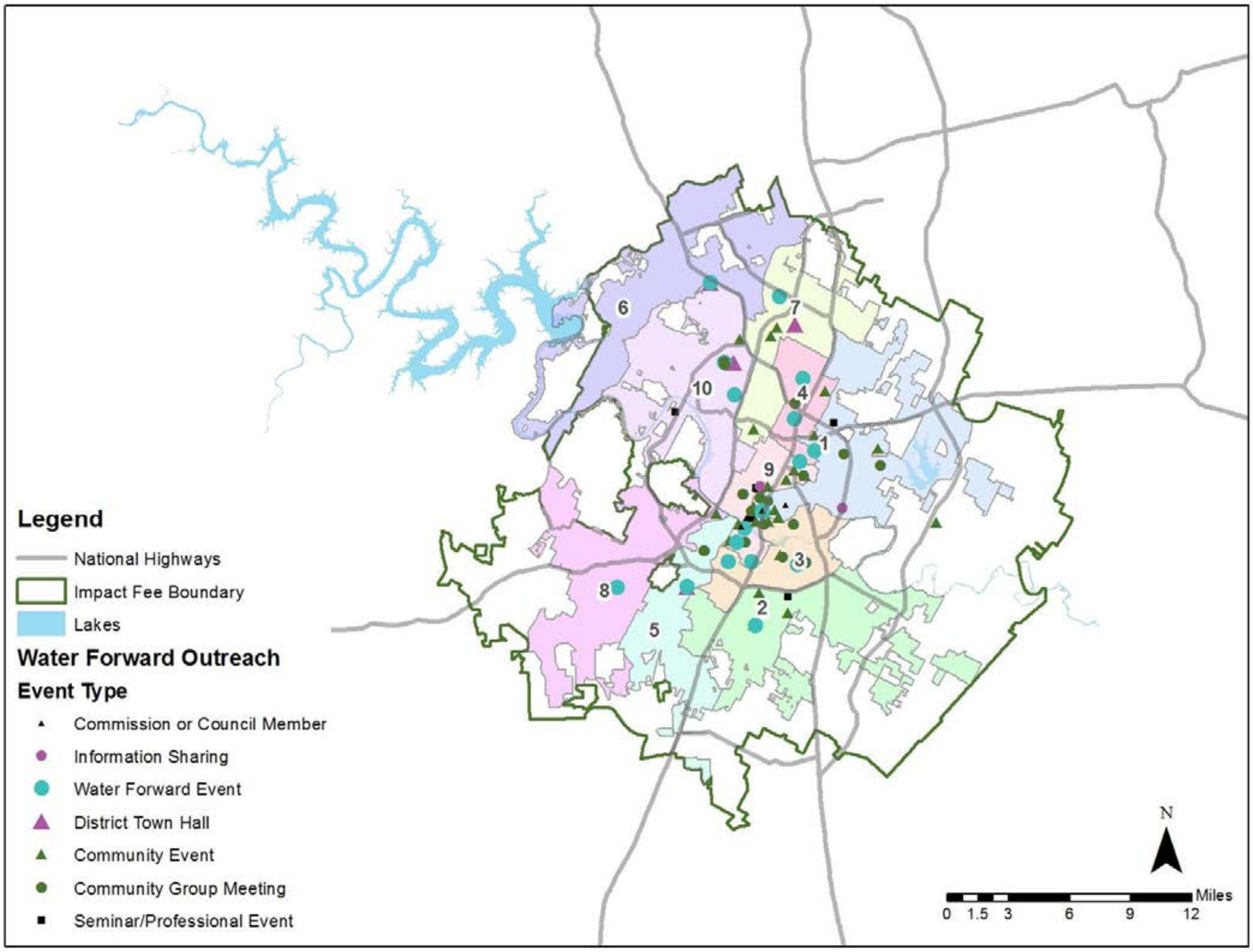

Figure 3-1. Map of Outreach Activities through May 2018

3.4 Evaluation Process Overview

The IWRP evaluation process was based on a planning process that explored both demand-side and supply-side options in an integrated manner in order to meet multiple objectives. The evaluation process also explored risks and uncertainty related to drought and different potential hydrologic and climatic futures over the next 100 years. The following section provides an overview of the planning process. A comprehensive description can be found in **Appendix B.** Integrated Water Resources Planning terminology is provided in **Figure 3-2.**.

Objectives	• Broadly stated goals of the IWRP that drive the evaluation process.
Sub-objectives	• Adds further clarity to the objectives, and forms the basis for the evaluation criteria used to score portfolios.
Performance Measures	• Metrics that indicate how well sub-objectives are being achieved.
Options	• Individual water supply and demand-side management projects or programs.
Portfolios	• Combinations of options that are evaluated against the performance measures.

Figure 3-2. Integrated Water Resources Planning Terminology

The Water Forward process is summarized in **Figure 3-3.**. The process began with defining the objectives, sub-objectives, and performance measures. The sub-objectives together with the performance measures served as the evaluation criteria which Water Forward portfolios were measured against.

The process continued with identification and characterization of various water supply and demand management options. Initially a large number of options were considered. This “blue-sky” list was screened down to a smaller number using a set of criteria. Those options that passed the screening process were characterized, meaning that they were further analyzed to develop more detailed cost, yield, and other information about each option.

In order to meet the goals of the IWRP process, including ensuring long-term resiliency, supply diversification, and sustainability in meeting the identified needs, groupings of options called portfolios were developed and evaluated.

Each portfolio was evaluated in terms of how well it achieved the defined objectives, including under various hydrologic conditions (for example, historical hydrology and climate change scenarios). The initially developed portfolios were scored and ranked, and then additional hybrid portfolios were developed based on what was learned during the initial scoring. The aim of the hybrid portfolios was to improve upon the ability to meet the stated objectives. Following final scoring, a preferred strategy was recommended for implementation. The preferred strategy was a combination of components from several high-ranking portfolios using an adaptive management approach that could implement various options within the portfolios based on triggers, such as demand growth, hydrologic conditions, and other factors.

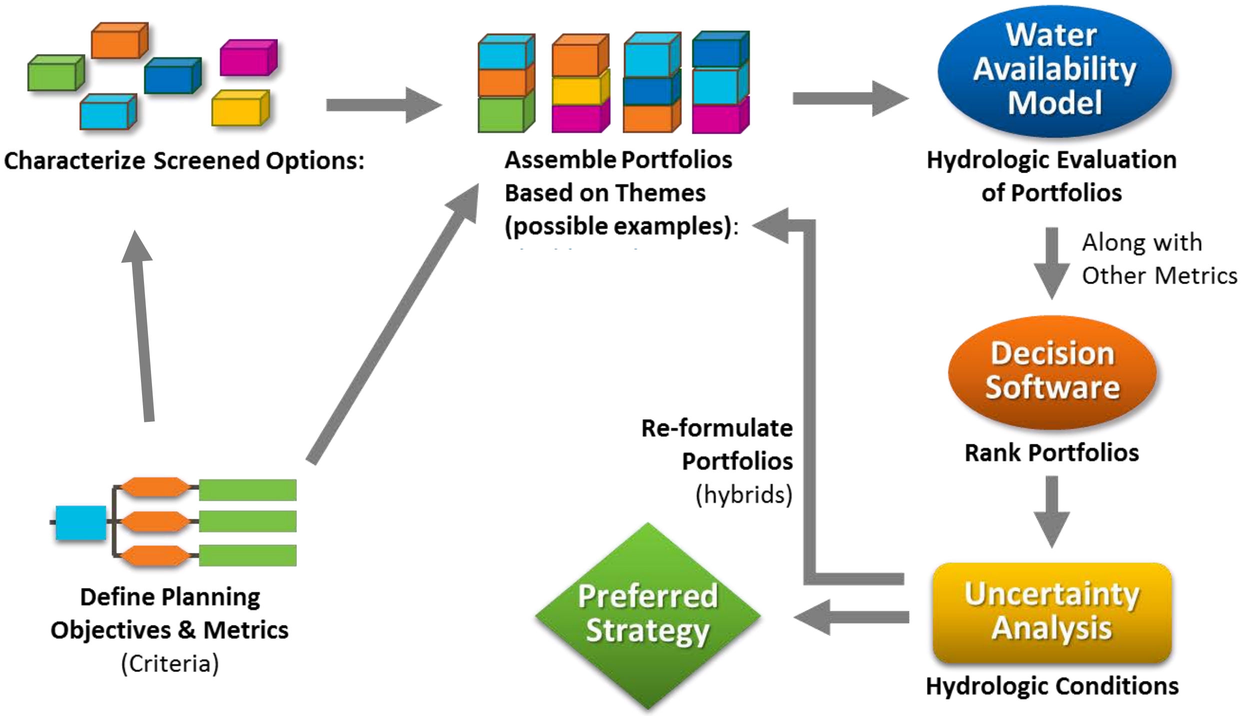

Figure 3-3. IWRP Planning Process

3.5 Plan Objectives and Performance Measures

The planning objectives serve as the framework for how the Water Forward Plan is developed. Objectives are usually categorized as either primary or secondary (sub-objectives). Primary objectives are more general, while sub-objectives help define the primary objectives in more specific terms. Sub-objectives should have the following attributes:

- **Distinctive:** to distinguish between one portfolio and another
- **Measurable:** to determine if they are being achieved, either through quantitative or qualitative metrics
- **Non-Redundant:** to avoid overlap and avoid bias in ranking the portfolios
- **Understandable:** to be easily explainable and clear
- **Concise:** to focus on what is most important in decision-making

The IWRP objectives and sub-objectives were developed by Austin Water with input from the Task Force. The objectives were formulated based on the previous 2014 Task Force and centered on principles of sustainability (balanced between economic, environmental, social needs). Initial sub-objectives were formulated with a “defining question” to establish the intent of the sub-objective.

For each sub-objective, a performance measure was developed. The performance measure was used to indicate how well a sub-objective is being achieved. Where possible, quantitative performance measures were established based on a review of available data and anticipated output from the various IWRP analyses, tools, and modeling efforts. In certain instances, a qualitative score was determined to be the most suitable performance measure. **Table 3-2.** presents the final list of primary objectives, sub-objectives, defining questions, and performance measures.

In any decision-making process, primary objectives are generally not all equally important. Thus, developing a set of weights is necessary to better reflect the difference in values and preferences among the various objectives. **Table 3-1.** shows the final weights given to each objective and sub-objective as determined by Austin Water and the consultant team with input from the Water Forward Task Force.

Outreach Highlight:
Public Workshop #1
Overview of IWRP and Objectives

Public input from the first Water Forward Public Workshop (held September 2016) informed the development of objectives and sub-objectives. Key feedback from this workshop included a desire to plan for future water supply reliability while maintaining affordability and continuing the community's focus on conservation.

Table 3-1. Objective and Sub-Objective Weights

Primary Objective	Objective Weight	Sub-Objective	Sub-Objective Weight
Water Supply Benefits	35%	Minimize Vulnerability	28%
		Maximize Reliability	7%
Economic Benefits	20%	Maximize Cost-Effectiveness	15%
		Maximize Advantageous External Funding	5%
Environmental Benefits	20%	Minimize Ecosystem Impacts	8%
		Minimize Net Energy Use	6%
		Maximize Water Use Efficiency	6%
Social Benefits	13%	Maximize Multi-Benefit Infrastructure/Programs	5%
		Maximize Net Benefits to Local Economy	4%
		Maximize Social Equity and Environmental Justice	4%
Implementation Benefits	12%	Minimize Risk	7%
		Maximize Local Control / Local Resource	5%
TOTAL	100%	**TOTAL**	100%

Table 3-2. Objectives, Sub-Objectives, Defining Question, and Performance Measures

Primary Objective	Sub-Objective	Defining Question	Performance Measure
Water Supply Benefits	Minimize Vulnerability	How much of the water needs[1] identified in the IWRP are met during 12-months of worst-case drought? Vulnerability describes the magnitude of shortages relative to defined water needs, if shortages occur.	Geometric mean of model results from different hydrologic scenarios. Percent of volume of water needs[1] met during worst 12-months of drought under various hydrologic scenarios.
	Maximize Reliability	How many months are water needs[1] identified in the IWRP fully met during the period of simulation? Reliability describes the frequency of shortages relative to defined water needs, if shortages occur.	Geometric mean of model results from different hydrologic scenarios. Percent of time water needs[1] were met during the period of record for various hydrologic scenarios.
Economic Benefits	Maximize Cost-Effectiveness	What is the total capital (construction) and operations/maintenance costs of all projects/programs in the portfolio over the lifecycle, divided by the sum of all water yield produced by the portfolio?	Unit cost ($/AF) expressed as a present value sum of all costs over the lifecycle, including utility and customer costs.
	Maximize Advantageous External Funding	Does the portfolio have an opportunity for advantageous external funding from Federal, State, local, and private sources?	External Funding Score (1-5), where 1 = low potential and 5 = high potential
Environmental Benefits	Minimize Ecosystem Impacts	To what extent does the portfolio positively or negatively impact receiving water quality (e.g., streams, river, lakes), terrestrial and aquatic habitats throughout Austin, and net streamflow effects both upstream and downstream from Austin?	Ecosystem Impact Score (1-5), where 1 = high combined negative impacts and 5 = high combined positive impacts
	Minimize Net Energy Use	What is the net energy requirement of the portfolio, considering energy generation?	Incremental net change in kWh
	Maximize Water Use Efficiency	What is the reduction in potable water use from water conservation, reuse and rainwater capture for the portfolio?	Potable per capita water use (gallon/person/day)
Social Benefits	Maximize Multi-Benefit Infrastructure/Programs	To what extent does the portfolio provide secondary benefits such as enhanced community livability/beautification, increased water ethic, ecosystem services, or others?	Multiple Benefits Score (1-5), where 1 = low benefits and 5 = high benefits
	Maximize Net Benefits to Local Economy	To what extent do the supply reliability and water investments of the portfolio protect and improve local economic vitality, including permanent job creation?	Local Economy Score (1-5), where 1 = high negative impact and 5 = high positive impact;
	Maximize Social Equity and Environmental Justice	To what extent does the portfolio support social equity and environmental justice, with emphasis on underserved communities?	Social Equity and Environmental Justice Score (1-5), where 1 = significant support and 5 = minimal support
Implementation Benefits	Minimize Risk	How significant are the major risks and uncertainties associated with implementation of projects?	Qualitative score (1-5), where 1=more water supply provided from high risk projects and 5 = less supply provided from high risk projects.
	Maximize Local Control/Local Resource	To what extent does Austin Water control operations of the water resource and is the resource from the local area?	Qualitative score (1-5), where 1=less water under Austin Water's control and from local water sources 5=more water under Austin Water's control and from local water sources.

[1] Water needs identified in the IWRP are referred to as Type 1, 2, and 3 Needs. These needs are described in Section 5: and quantified in Section 8

Outreach Highlight: Targeted Stakeholder Meetings
Demand Management Options

In January 2017, Austin Water hosted a series of three Targeted Stakeholder Meetings. Input from landscape and irrigation professionals, representatives of environmental interest groups, and various professional groups informed refinement of demand management options that were selected for screening.

The combination of the Economic, Environmental, and Social benefits categories comprises the triple bottom line of sustainability. The City of Austin's official definition of sustainability is finding a balance among three sets of goals: 1) prosperity and jobs, 2) conservation and the environment, and 3) community health, equity, and cultural vitality. It means taking positive, proactive steps to protect Austin's quality of life now, and for future generations.

3.6 Options Screening and Characterization

Prior to developing portfolios for detailed evaluation, it was important to evaluate individual supply and demand management options to allow for more informed portfolio development and ultimately portfolios that are better suited to meet overall Water Forward objectives. To do this, two key steps were required: options screening and a standardized options characterization process.

3.6.1 Options Screening Method

The blue-sky list of options went through an initial process of combining similar options to create a total of 21 water supply options and 25 demand management options. These were identified for screening by Austin Water. Through a screening process described in more detail below, these 46 options were narrowed down to a total of 13 supply and 12 demand management options that were carried forward for further characterization. The list of options identified for screening fell under the following main categories:

- Water Conservation Options
- Lot-scale Decentralized Options (e.g., rainwater harvesting, stormwater harvesting, graywater reuse, blackwater reuse, or air conditioner (A/C) condensate reuse)
- Centralized and Community-Scale Decentralized Wastewater Reuse Options
- Storage Options (e.g., Aquifer Storage and Recovery or a New Off-Channel Reservoir)
- New Supply Options (e.g., desalination of brackish groundwater)

Outreach Highlight: Public Workshops 2 & 3
Future Water Supply Needs and Strategies to Meet Them

In February and April 2017, Austin Water hosted two public workshops to learn more about community perspectives on potential demand management and supply options. Dot exercises at the workshop allowed participants to indicate options they did or didn't prefer. Feedback from these workshops and from the online surveys posted after the workshops informed the screening of options.

The screening process compared a high-level, order-of-magnitude unit cost of the options to a performance score (combining implementation challenges and hydrologic resiliency) created specifically for option screening. All of the options were then plotted by these two parameters to see where outliers existed. The highest performing options were recommended to move forward for more detailed characterization. More detail about the screening process can be found in **Appendix H** for demand management options and in **Appendix I** for water supply options.

3.6.2 Options Characterization Process

For options carried forward from screening to portfolio evaluation a summary characterization was developed using a standardized *Options Characterization Template*. During characterization, potential yields were estimated along with capital costs and annual operational costs. Option characterizations are based on the best available technical information; however, more detailed analysis of options will be required prior to implementation. The final set of option characterization sheets can be found in **Appendix J**.

3.7 Portfolio Development and Evaluation

Portfolio development and evaluation is a core part of the integrated water resource plan development process used in this Water Forward planning effort. Through portfolio development this process created different groupings of options that were composed to meet the identified needs. The options that were grouped together to make each portfolio were in addition to the core water resource strategies including the Colorado River water supply, water savings from the existing water conservation program, and existing reclaimed water program. This integrated water resource plan approach allows for evaluation of the different portfolios to see how well the sets of new options could come together to develop a plan with diversified strategies. Adding strategies to Austin's water supply and demand management portfolio would strengthen Austin's supply diversification, which aligns with the plan's guiding principles. Benefits of diversification include increased resiliency, strengthening of reliability, and increased preparedness for managing risks associated with future uncertainties.

Options that had been characterized were selected from to develop initial Water Forward portfolios. Water supply and demand management options were combined into portfolios that meet the identified water supply needs and targets under different hydrologic scenarios to various degrees of reliability.

Portfolios were developed based on themes (as described in Section 3.7.2) important to Austin's community, identified as part of the Water Forward public outreach process. These portfolios were then evaluated against the IWRP sub-objectives using the previously defined performance measures. The IWRP analyses were conducted for the forecast years 2020, 2040, 2070, and 2115, and portfolios were compared and ranked using combined scores factoring in the different forecast years. The planning horizons of 2020, 2040, 2070, and 2115 were selected to provide a range of near to long-term planning horizons to take a snap-shot of future projected conditions to plan for. The goal of the process was to develop a 100-year integrated water plan for Austin. As such, 2115 became the most distant planning horizon. To roughly represent a 50-year planning horizon, and sync with the furthest out planning horizon currently used in the Texas Water Development Board-administered regional water planning process, 2070 was selected as the next planning horizon. Years 2020 and 2040 (roughly 20-years out) represent two relatively near-term time horizons that frame the near-term steps to be taken to achieve plan goals.

3.7.1 Preliminary Water Needs Assessment

A fundamental objective for the IWRP is that identified future water needs for Austin Water are reliably met. For the purposes of portfolio development, three types of water needs were established: (1) new conservation and/or supply to manage risk associated with drought conditions triggering prolonged prohibition on outdoor water use; (2) new supply to manage risk associated with extremely low Highland Lake levels; and (3) new conservation and/or supply to provide for Austin water demands above the current Lower Colorado River Authority contract of 325,000 AFY.

Section 5.1 includes definitions of the preliminary water needs and how they relate to drought conditions. Section 8.1 contains estimates of the needs amounts using baseline demand conditions before portfolio options are applied and using water availability model hydrologic scenario B (period of record with projected climate change effects). **Appendix F** also includes a more detailed description of the types of water needs identified in the planning process.

3.7.2 Method for Formulation of Portfolios

In order to meet the goals of the IWRP process, including ensuring long-term resiliency, supply diversification, and sustainability in meeting the identified needs (described in **Section 3.7.1**), groupings of options called portfolios were developed and evaluated. Portfolios are developed around major themes that align with the IWRP objectives. By developing these initial portfolios that "push" the limits of achieving each of the most important objectives, trade-offs can be identified in developing "hybrid" portfolios that are more balanced and have a better likelihood of meeting numerous objectives.

Initial portfolio themes included:

- **Minimize Cost:** Options with the lowest unit costs ($/acre-foot/year) were generally selected.
- **Maximize Conservation:** Options that conserve water and maximize the reuse of treated wastewater and stormwater were generally selected.
- **Maximize Reliability:** Options that provide higher supply reliability and resiliency in terms of climate and hydrology were generally selected.
- **Maximize Ease of Implementation:** Options that have a higher degree of potential implementation success were generally selected.
- **Maximize Local Control:** Options in which Austin Water would have control over the projects and the water supplies in terms of cost, yield, development, and operations were generally selected.

Outreach Highlight: Summer Series and Community Values Survey

During the summer of 2017, Austin Water hosted ten Summer Series meetings (one in each Council District) to gather input on themes to be used to develop initial portfolios. The emerging themes that were discussed in the Summer Series meetings had been identified from Community Values Surveys that Austin Water collected at in-person outreach events and online. Summer Series input informed the final selection of initial portfolio themes.

3.7.3 Portfolio Evaluation Method

When evaluating a diverse set of portfolios against multiple objectives it is typically difficult to find a single portfolio that meets the needs or priorities of every stakeholder. Instead, the goal is to evaluate trade-offs between options and objectives, which will be used make an informed decision in selecting a preferred portfolio. To do this, the Water Forward process uses multi-criteria decision analysis to evaluate portfolios. The multi-criteria decision analysis process relies on the performance measures and performance weights (outlined in previous sections) and a suite of computer-based tools. However, it is important to note that the plan recommendations are based on human judgement, not just computer model output. The computer model results helped inform the process of developing plan recommendations.

3.7.3.1 Overview of IWRP Tools

The multi-criteria decision analysis process for evaluating portfolios was dependent upon output from other models and tools, as well as input from participants and subject-matter experts. Each portfolio underwent modeling and assessment that generated raw quantitative and qualitative performance measure scores. **Figure 3-4.** shows the portfolio evaluation workflow of IWRP tools. The models and tools used for the Water Forward process are briefly described below:

- **Colorado Basin Water Availability Model (WAM)** – This is a customized version of the computer-based simulation model, originally developed and used by the Texas Commission on Environmental Quality, quantifying the amount of water that would be flowing in the Colorado River and available to meet water rights under a specified set of conditions (e.g. water use, naturalized hydrology, etc.).
- **Disaggregated Demand Forecasting Model** – This is a water demand forecast model that projects demands geospatially by sector (e.g., single-family residential, multi-family, and commercial) and by end uses (e.g., toilet flushing, showers, landscaping, industrial process). The demand model also includes functionality to evaluate impacts of water conservation, weather and climate, and price of water.
- **Geospatial Decentralized Supply Suite of Tools** – These represent a set of geospatial analysis tools which incorporates the end uses of water demands by sector, and evaluates the potential demand met by alternative water options, cost, and avoided costs associated with stormwater and rainwater capture, graywater reuse, and blackwater reuse.
- **Portfolio Evaluation Spreadsheet Tool** – This spreadsheet tool was utilized to assemble options into portfolios based on supply needs and targets (difference between existing supplies and future demands and targets under different hydrologic scenarios); and also, was used to estimate total portfolio costs from individual unit costs for each option.
- **Criterium Decision Plus** – This is an industry-leading commercial multi-criteria decision analysis software to compare and score portfolios (see below for detailed description).

3.7.3.2 Description of Criterium Decision Plus Software

Criterium Decision Plus was used to rank portfolios. This software tool converts raw performance measures for each sub-objective, which each have different measurement units, into standardized scores so that the performance measures can be summarized into an overall value. Through Criterium Decision Plus, a multi-attribute rating technique is applied to score and rank the selected portfolios. **Figure 3-4.** summarizes the multi-attribute rating technique that is used by Criterium Decision Plus to compare and score portfolios. The figure represents a generic scoring example and is meant as an illustration of the approach.

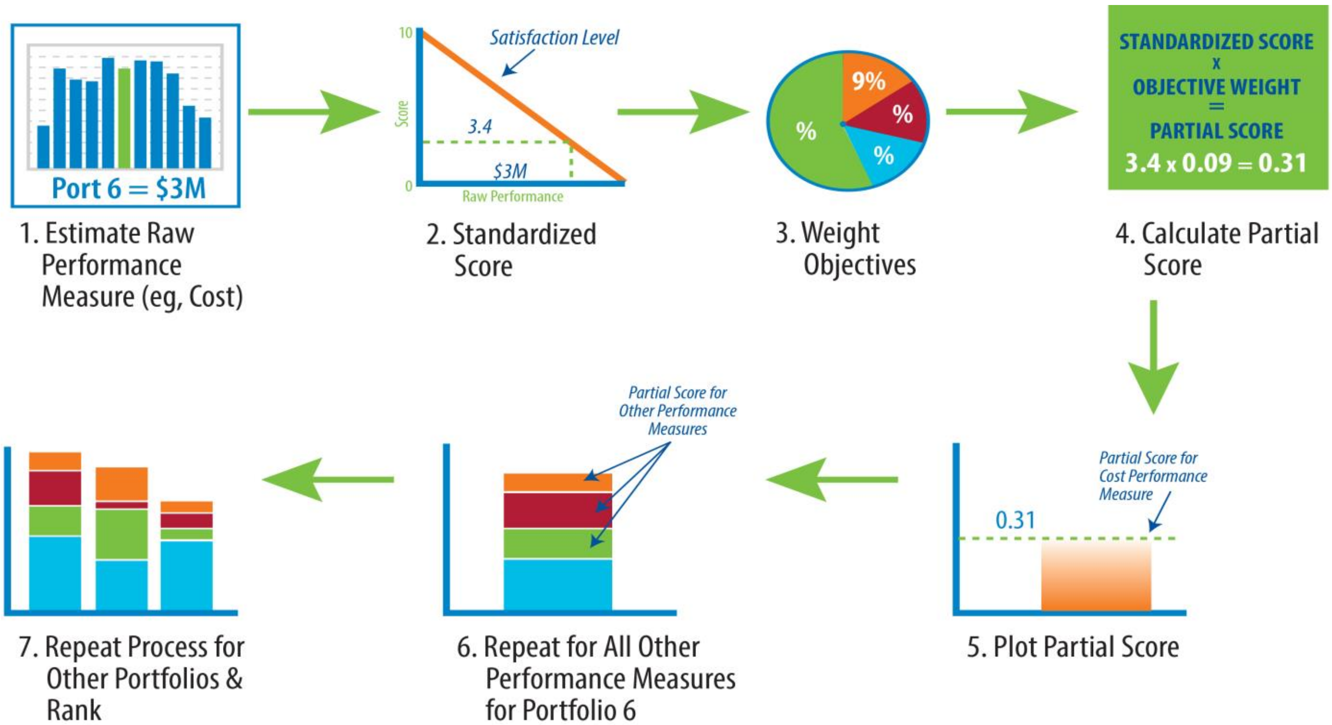

Figure 3-4. Multi-Attribute Rating Technique Used by Criterium Decision Plus Software to Score Portfolios

Multi-attribute rating uses 7 steps to score and rank portfolios. In step 1, raw performance for all the portfolios is compared for a given criterion (for example, cost). Step 2 standardizes the performance into a score from 0 to 10. In this example, Portfolio 6's cost performance is fairly expensive, so its standardized score is fairly low (e.g., 3.4 out of 10). This step is important because performance is measured in different units (i.e., cost in dollars, energy in kWh). Step 3 assigns weights to the objective and Step 4 calculates a partial score for a given portfolio based on the multiplication of the standardized score (Step 2) and weight (Step 3). The partial score is plotted (Step 5), and then the whole process is repeated for a given portfolio for all the other performance measures (Step 6). This creates a total score that can then be compared to other portfolios. Steps 1-6 are repeated for all portfolios and compared so they can be ranked (Step 7).

3.7.3.3 Description of Colorado River Basin Water Availability Model

The Texas Commission on Environmental Quality Water Availability Model (WAM) is a publicly-available computer modeling system for simulating surface water availability. The WAM System covers every river basin in Texas. It was created pursuant to Article VII of the 1997 Senate Bill 1, which required the development of new water availability models for the state's river basins. The WAM system is comprised to two components: generalized computer modeling software known as the Water Rights Analysis Package and a set of basin specific input files and supporting geographic information system (GIS) coverages. The Water Rights Analysis Package was developed and is maintained by Dr. Ralph Wurbs at Texas A&M University. The basin specific input files and GIS coverages were developed in the late 1990's and are updated and maintained by the Texas Commission on Environmental Quality.

The WAM uses monthly naturalized streamflow, net lake evaporation minus precipitation, and a water management scenario as its three main inputs for every river basin. Naturalized streamflows are calculated from historical streamflow gaging records by reversing the historical water diversions, changes in reservoir storages, and return flows of all state granted water rights. The naturalized flows represent the total surface water production of the basin in the absence of state granted water rights. The WAM simulates surface water availability to the basin water rights using the naturalized hydrologic inputs and a water management scenario that specifies a level of water right utilization. Outputs of the WAM include water diversion, reservoir storage content, and remaining streamflow after accounting for the water management activities.

The Colorado River Basin WAM covers the entire portion of the river basin in Texas, from the border of southeast New Mexico downstream approximately 600 miles to the Matagorda Bay. The Colorado basin contains approximately 31,000 square miles of contributing drainage area. There are over 2,000 water rights and over 500 major and minor reservoirs represented within the Colorado WAM. The Colorado WAM uses naturalized hydrology with a period of record from January 1940 through December 2013. Extended synthesized hydrology was developed for Water Forward to cover the additional years of the recent drought through December 2016.

The City of Austin is using the Colorado River Basin WAM as a key modeling tool to examine water available to the City of Austin and the lower Colorado River Basin for the worst drought conditions in the historical period of record, drought conditions that are worse than observed in the period of record, and drought conditions that are reflective of future climate change. Water availability is simulated for a baseline water management scenario (no additional actions) to assess future needs, and a suite of portfolio options to assess the performance to meet those future needs.

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SECTION 4: WATER DEMANDS

Integrated water resource planning provides a blueprint that ensures residents and businesses in Austin have sustainable access to clean water now and into the future as the city continues to experience growth. To properly plan and manage Austin's water resources, it is critical to have a reasonable understanding and characterization of how and where water is currently used in the city as well as quantifiable estimates of how much water will be needed in the future. This section describes the primary tool used by Water Forward to characterize and explore water demands, referred to as the Disaggregated Demand Model. This tool was developed by Austin Water staff with indoor end use refinements and other enhancements developed by CDM Smith. Using the tool, current water use is defined, as described in **Section 4.2**, and future demand is projected, as described in **Section 4.3**. These sections describe the City's water demand at the water source (*diversions*), at the water treatment plant (*pumpage*), and at the Austin Water customers' meters (*consumption*). Climate and weather patterns are a major defining factor in water use levels. Section 4.4 explores future water demands in relationship with projected climate variations.

AT A GLANCE

- *Disaggregated Demand Model*
- *Current Water Use Summary*
- *Future Baseline Water Demand*

4.1 Disaggregated Demand Model (DDM)

The foundation of the IWRP water demand estimates is the underlying DDM, which was used to produce the baseline water demand assessment, among other things. Austin Water staff began development of the DDM in advance of the IWRP, and refinements to the DDM have continued throughout the process. The DDM is an Excel-based tool that models water use by sector, subsector, and end use at a geographic planning unit scale for current demands as well as the key planning horizons of 2020, 2040, 2070, and 2115. The DDM provides the analytical environment for assessing potential water savings from demand management measures being evaluated in developing the plan. The DDM also includes functionality to assess water demands under future climatic scenarios and tracks water consumption by end uses (such as toilets, sinks, or irrigation) which informs the assessment of yield potential for decentralized supply options. The following sections describes the model attributes, development, and primary data sources.

4.1.1 Demand Model Attributes

For analysis purposes, it is useful to group water demands according to similar user characteristics. These groupings are known as sectors. The DDM model sector classifications are listed below. The water use sectors are further refined into subsectors and outdoor and indoor end uses, as shown in **Figure 4-1.**

DDM Sectors:

- Single family residential (SFR)
- Multi-family residential (MFR)

- Commercial (COM), which includes large volume customers in the Industrial subsector
- Wholesale Customers (WHL)
- City of Austin (COA)

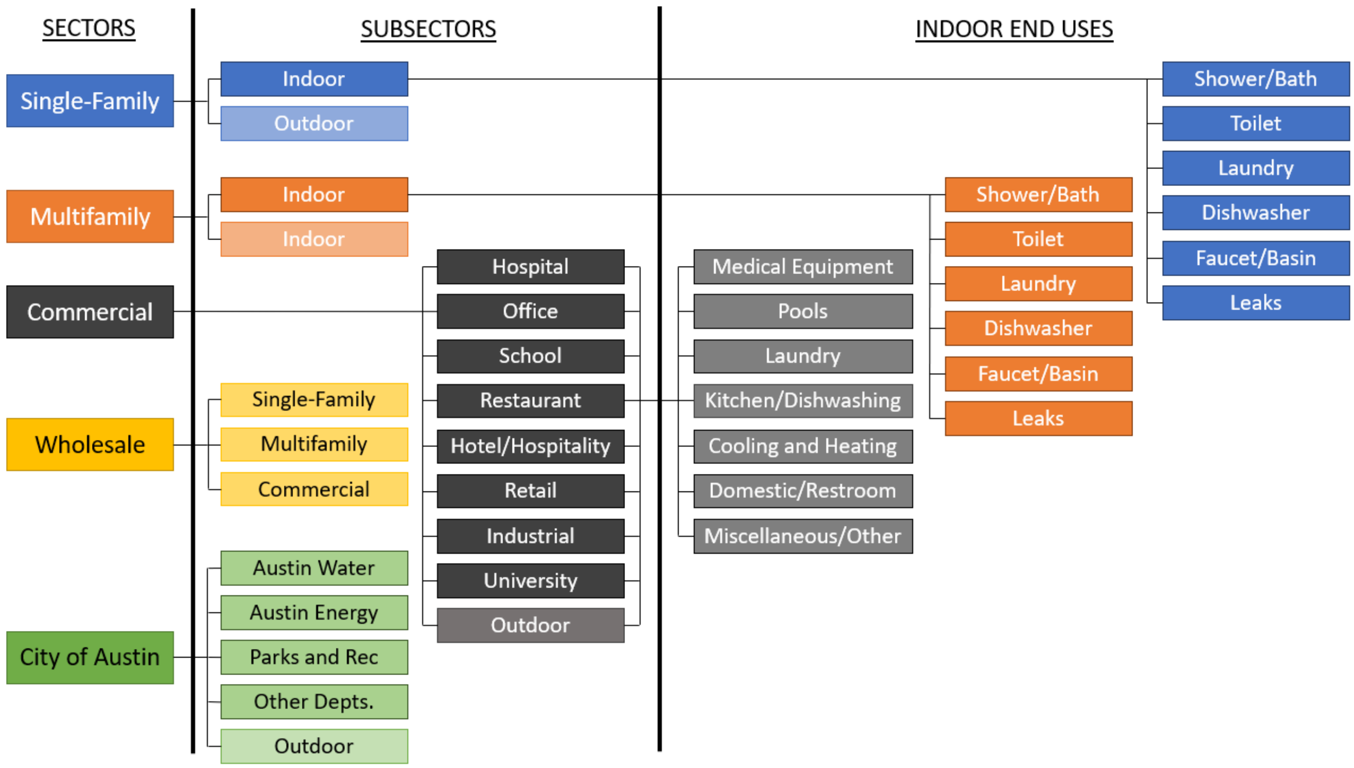


Figure 4-1. Disaggregated Demand Model Sectors, Subsectors, and End Uses

Analysis was conducted using geographic units developed in harmony with Imagine Austin, Austin's comprehensive plan. The geographic units are known as the Delphi, Trends, and Imagine Austin (DTI) polygons and they divide the city into 230 contiguous polygons. The area coverage by the DTI polygons includes the City of Austin's full and limited purpose jurisdictions as well as the city's extra-territorial jurisdiction, as shown in **Figure 4-2.** The green water planning area boundary represents the potential future service area extent for Austin Water. Census blocks within the DTI polygons were used to create a comprehensive 2010 baseline count of the population and number of residential units in each polygon. Employment estimates were also generated for each polygon. These baseline and projected demographics are the primary drivers of water use in the city. So, for each DTI polygon, an estimate of existing and future water demands by sector, subsector, and end use were able to be developed by the tool. More detail on the development of these estimates can be found in **Appendix C**.

The DDM also produces a number of summary charts, tables, and graphics that support and inform the IWRP. For example, the tool allows for relatively quick assessment of the impact of a demand management measure on overall system, sectoral, or source water demand.

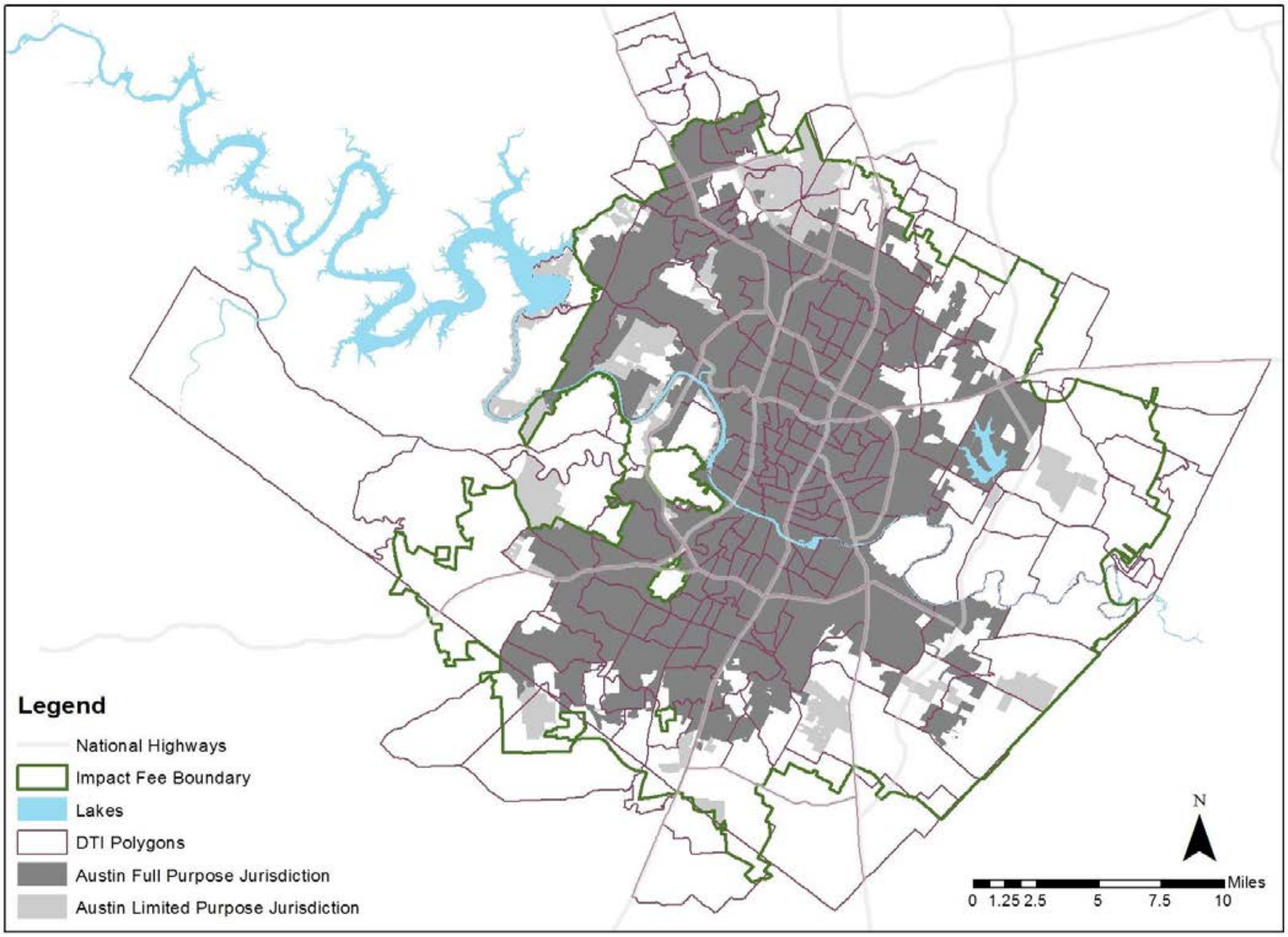


Figure 4-2. Disaggregated Demand Model DTI Geographic Units

4.1.2 Model Development

The DDM was developed by Austin Water staff using a bottom-up approach that relied on detailed, account-level billing data from 2010 through 2015. Data from 2011 was not utilized due to a change in billing systems which introduced errors into the data for that year. For each active account, the DTI polygon location was identified. Customer types and rate codes were used to determine the water use sector of the account. All billing sets were normalized to calendar month usage using the daily average of the billing cycle and the number of days in the billing cycle that occurred in each calendar month.

Water use data were then aggregated by subsector, DTI polygon, and month. Using the DTI polygon data for demographics and the aggregated water use, water use factors were calculated for each polygon for each year. Water use for single and multi-family residential customers was based on population within those housing types while commercial and City of Austin water use was based on employment within the sector.

The industry standard minimum month method was used to estimate the portion of monthly water demands that are used for outdoor, seasonal applications. Specifically, the lowest monthly water usage for each parcel without a dedicated irrigation meter was identified. This value was multiplied by 12 to estimate the total annual indoor usage for each parcel. The difference between the total parcel water usage and the calculated indoor usage was identified as annual outdoor usage. In instances where dedicated irrigation meters are present on a parcel for a given sector, all the water use from the meter was assigned the outdoor subsector and the meter representing indoor use was assigned to the indoor subsector.

To estimate current indoor end uses, research was done to identify and use best available data sources. Indoor end uses for single family residences were informed by the Water Research Foundation's Residential End Uses of Water, Version 2 Report[4]. The multi-family residential and commercial indoor end uses were developed based on a comprehensive literature review of available information coupled with insight and guidance from Austin Water staff. Additional details can be found in **Appendix C**.

For forecasting, the average water use factor from 2013 through 2015 was calculated and assumed to be the starting point of the forecast. The water use factors were adjusted in the forecast years based on the given analysis scenario. The baseline scenario includes adjustments to the water use factors based on an assumption that, as a best management practice, Austin Water will incentivize or require installation of water efficient fixtures in homes and businesses throughout the city. This was referred to as "passive conservation" in the model (see **Appendix C** for more detailed information). In addition to passive conservation, the baseline scenario embeds and assumption that active conservation measures taken by Austin in the past, including one-day-per-week watering restrictions, will be maintained in the future. In support of the IWRP, the DDM was enhanced to allow for modeling of future demands under different weather conditions. Details on model enhancements can be found in **Appendix C**.

4.1.3 Data Sources

The primary data sources for developing the DDM are described below:

- Delphi – Trend – Imagine Austin (DTI) Polygons - Geographic unit of analysis for Austin Water DDM. The data include long-range, small-polygon-based population and employment forecasts. The City of Austin Demographer worked closely with Austin Water staff to develop estimates of retail and wholesale water service population that built off of historical 2010-2015 estimates and extended projections through 2115. This dataset contains estimates of water service population, single family and multifamily units, and employment figures for 2010, as well as projections for 2020, 2040, 2070, and 2115 (see Table 4-1 below).
- Standardized Occupational Components for Research and Analysis of Trends in Employment System (SOCRATES) Employment Dataset - Dataset created by the Texas Workforce Commission featuring a complete listing of employers within Austin as well as pertinent data (number of employees, North American Industry Classification System code, sales volumes, etc.) for the year 2010.
- Austin Water Billing Accounts and Consumption Data - Historical billing records (in the form of GIS feature point datasets) for every Austin Water customer in 2010 and 2012-2015. Note that 2011 data were excluded due to errors introduced when the city switched billing systems.
- COA Building Permit Data - All approved building permit data provided by the city's Development Services Department in the form of a database (the Application Management and Data Automation database known as AMANDA) and Shapefiles of permits by year.
- 2010 Land Use GIS polygon.

[4] http://www.waterrf.org/PublicReportLibrary/4309A.pdf

Table 4-1. Long-Range Population Forecast for Austin Water Planning Area

Year	Austin Water Served Population Forecast – Retail and Wholesale	Annualized Growth Rate
2010	875,936	
2015	977,491	2.2%
2020	1,101,632	2.4%
2025	1,216,291	2.0%
2030	1,342,884	2.0%
2035	1,464,571	1.7%
2040	1,577,760	1.5%
2045	1,692,174	1.4%
2050	1,808,586	1.3%
2055	1,927,901	1.3%
2060	2,051,178	1.2%
2065	2,179,649	1.2%
2070	2,314,769	1.2%
2075	2,458,265	1.2%
2080	2,610,656	1.2%
2085	2,772,495	1.2%
2090	2,944,366	1.2%
2095	3,126,892	1.2%
2100	3,320,732	1.2%
2105	3,526,590	1.2%
2110	3,745,208	1.2%
2115	3,977,380	1.2%

4.2 Current Water Use Summary

Over time, average annual water use on a per capita basis has been declining in Austin. This water use savings is occurring through increased water use efficiency and efforts by the Austin community to conserve and respond to calls for water use reduction during the recent drought. As shown in **Figure 4-3.**, through much of the 1990's both water use and population were increasing at similar rates. With the onset of water conservation programs initiated by the City, like conservation-based water rates or outdoor watering schedules, as well as more efficient water fixture standards implemented by first the federal government in 1992, the City in 2007, and then the State of Texas in 2010, water use has declined despite continued population growth. On a per capita basis, annual water pumpage has declined from 190 gallons per capita per day (GPCD) in 2006 to a low of 122 GPCD in 2015 and 2016 as shown in **Figure 4-4.**

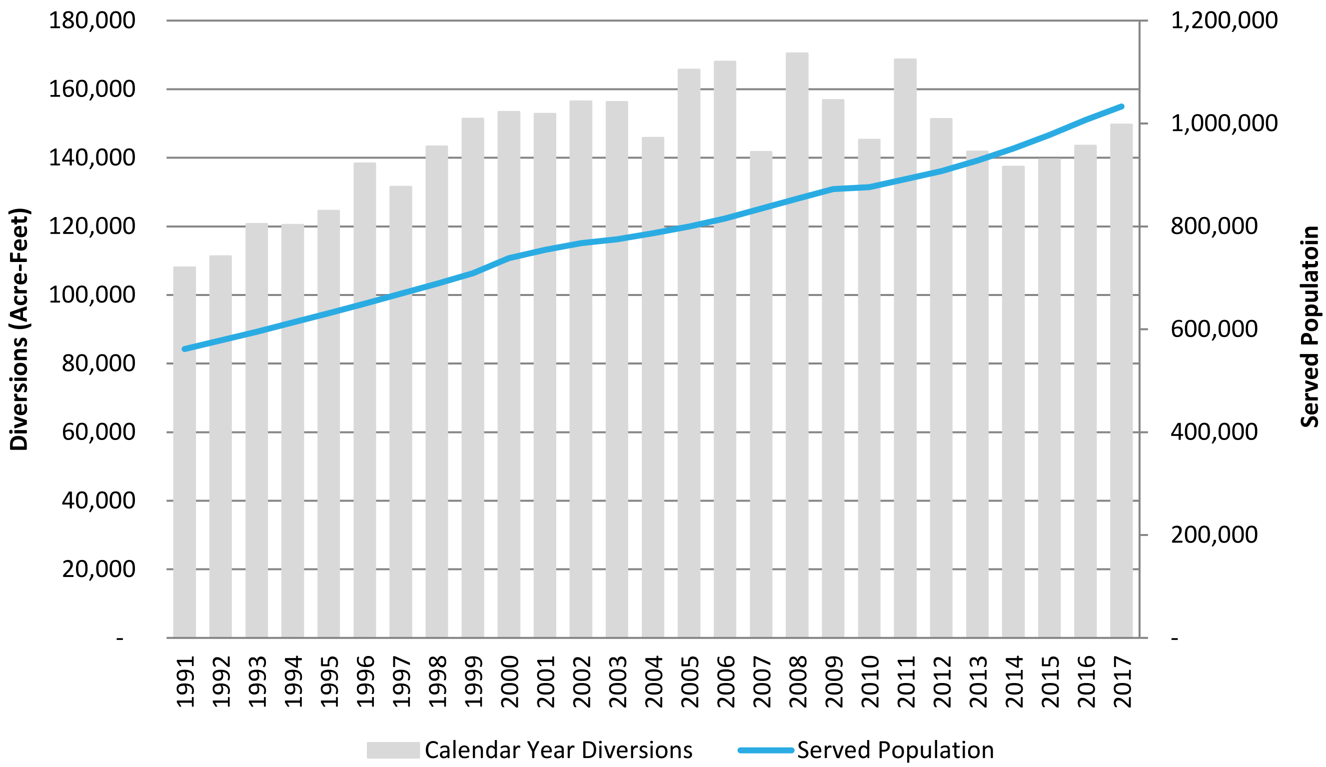


Figure 4-3. Water Diversions and Population from 1989 through 2015

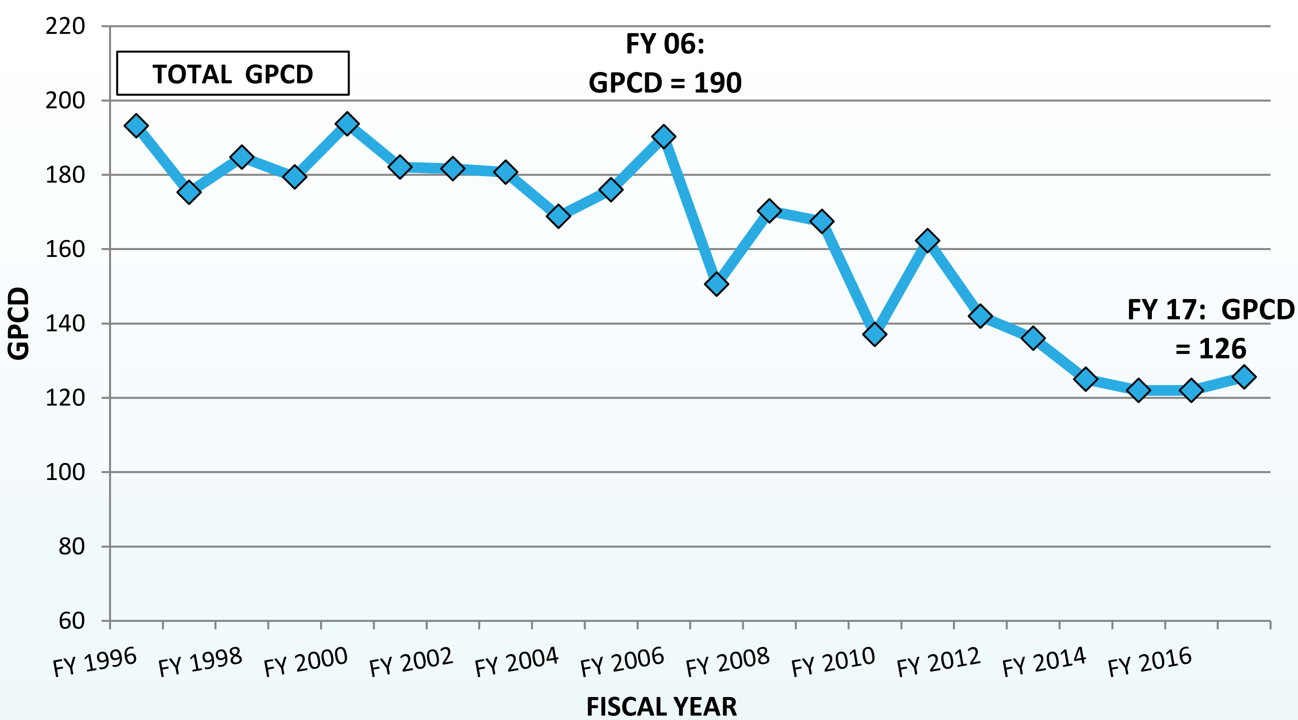


Figure 4-4. Historical Per Capita Water Demand

The baseline municipal annual use estimate for an average of 2013, 2014, and 2015 for Austin Water and its customers was approximately 45.4 billion gallons (139,300 acre-feet) of raw water diversions. The baseline total pumpage of treated water into the distribution system per year is approximately 44.1 billion gallons (135,500 acre-feet). The difference between raw water diversions and treated water pumpage is attributable to several factors, including use of some of that water in the treatment process itself, water loss due to evaporation, and metering differences. The baseline amount of water consumed by Austin Water and its customers was approximately 39.29 billion gallons (120,600 acre-feet), based on an average of 2013, 2014, and 2015 water consumption. The difference between treated water pumpage and consumption is known as non-revenue water. Some non-revenue water is lost through leaks in pipes on the way to customers, while other components of non-revenue water include water used for distribution pipe flushing or fighting fires.

Of the water consumed, residential use accounts for 60% and commercial use accounts for 31% (**Figure 4-5.**). Currently, outdoor use is estimated to be 27% of all single-family residential use, 16% of all multi-family residential use, and 23% of total commercial use.

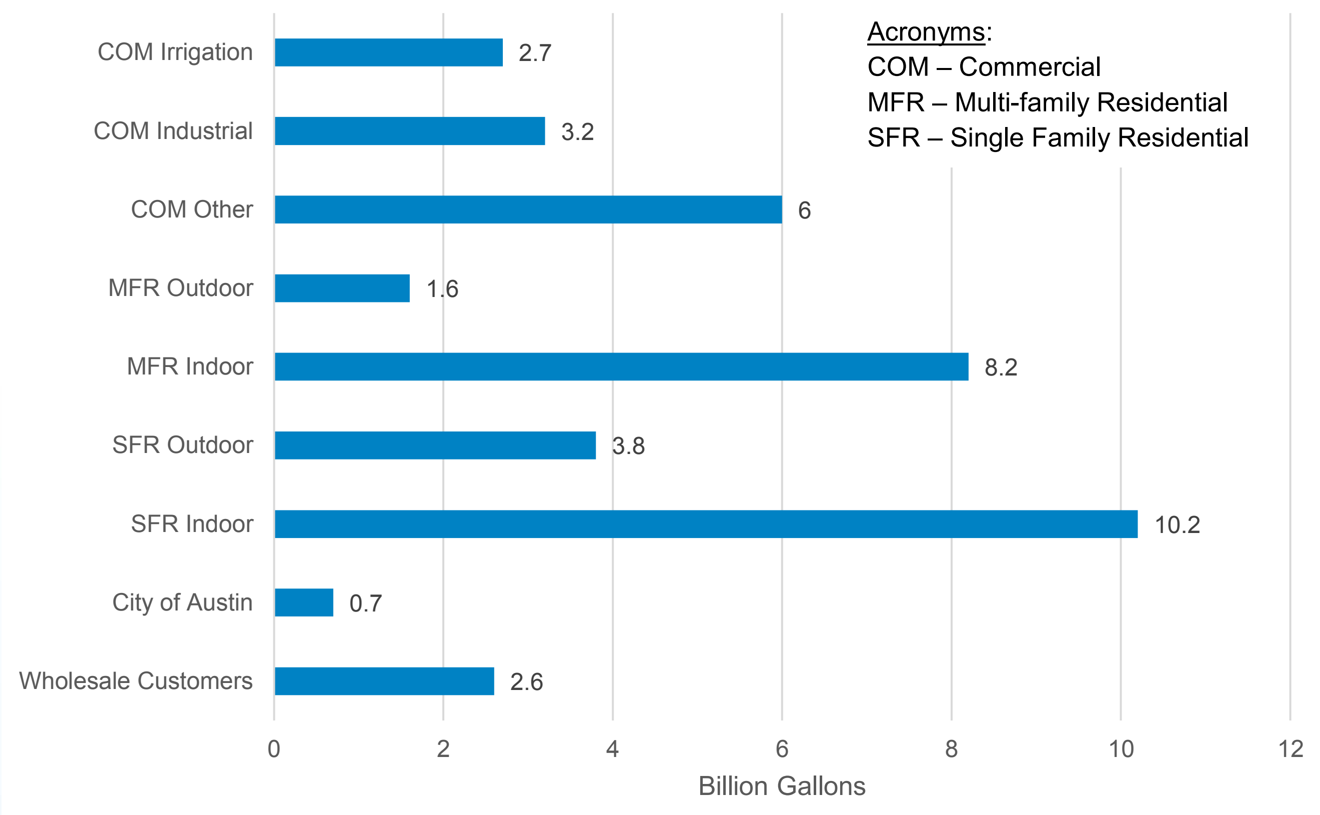


Figure 4-5. Current Water Consumption by Sector and Subsector

4.3 Future Baseline Water Demand

Baseline future water demands were developed from an average of 2013, 2014, and 2015 water consumption (also known as base year demands) and represent future conditions based on demographic projections of population, housing, and employment in Austin. An average of 2013, 2014, and 2015 water consumption was chosen to develop future demands and embeds recent conservation savings such as Austin's one-day-per week watering for automatic irrigation systems. Baseline water demands also incorporate projected passive conservation, which can result from reductions in water use from existing conservation and continued improvements primarily in indoor water using fixture efficiencies.

As shown in **Figure 4-6.**, under current baseline conditions, without potential future water strategies, the City is projected to need 148.13 billion gallons (or 454,600 acre-feet) of water by 2115 to serve a projected population of slightly less than 4 million people. This figure is based on treated water pumpage, under stationary climate conditions. Austin's corresponding baseline water diversion projection, which accounts for water used in the water treatment process, is 467,392 acre-feet by 2115. It is important to note that baseline water demands do not include future conservation savings from additional conservation programs, codes, or ordinances. Additionally, baseline demands do not reflect reductions in potable water demand due to future increases in centralized and decentralized alternative water use. Alternative water sources include highly treated reclaimed water from Austin Water's wastewater treatment plants, and onsite water sources such as rainwater, graywater, blackwater, air conditioner condensate and stormwater. Demand projections that incorporate the implementation of Water Forward plan recommendations show a marked decrease in future projected demands from baseline demands.

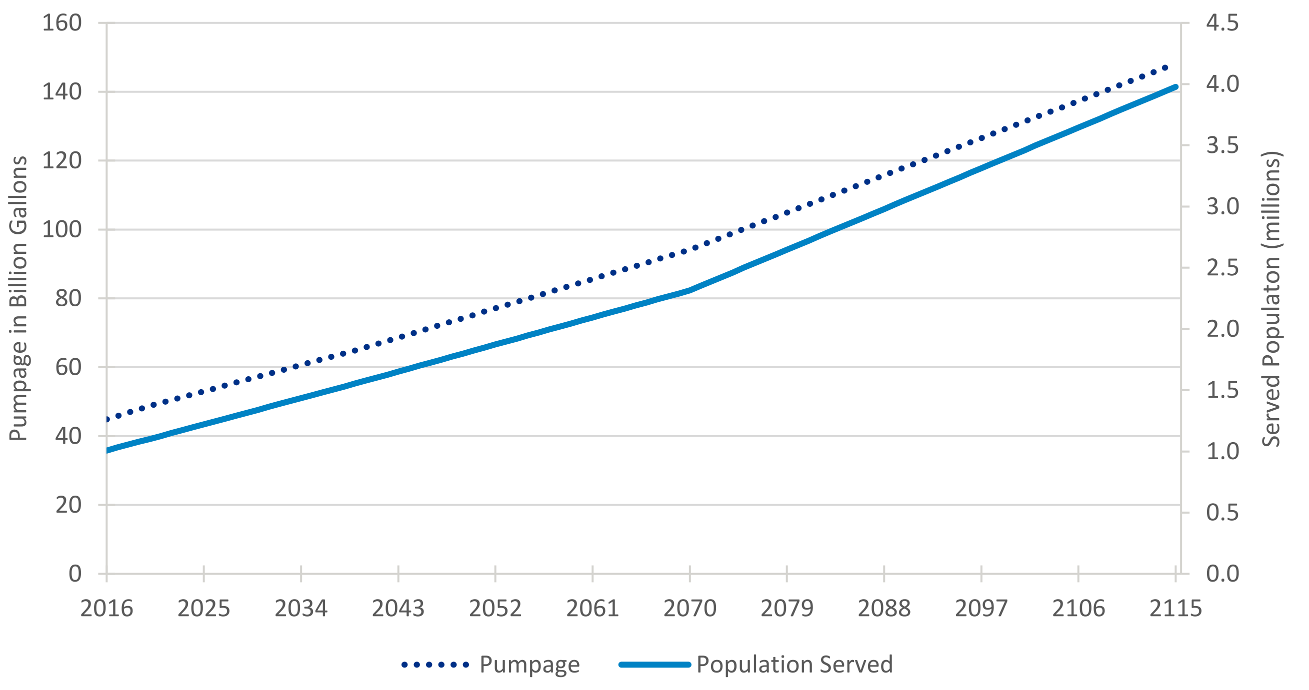


Figure 4-6. Baseline Water Pumpage Forecast with Population to 2115

Table 4-2 and **Figure 4-7.** presents the baseline water demand forecast by sector. Baseline system pumpage is projected to grow by 236% from its current level over the next 100 years. Again, this projection does not include projected effects of water use savings of potential future demand management or other strategies that may be recommended as part of this plan. The commercial sector growth rate of nearly 270% captures the trend that employment is projected to grow at a rate greater than population served.

Table 4-2. Baseline Water Demand Forecast by Sector to 2115 – Consumption, Pumpage, and Demand

Sector	Base Year Demand (Billion Gallons Per Year)	Future Water Demand (Billion Gallons Per Year)			
		2020	2040	2070	2115
Single family residential	13.99	15.61	19.98	28.22	41.99
Multi-family residential	9.76	11.13	14.81	22.66	42.47
Commercial	12.03	13.16	18.02	27.60	44.39
Wholesale	2.64	2.43	2.79	3.32	3.53
City of Austin	0.70	0.89	1.48	2.05	3.07
Other	0.16	0.18	0.23	0.34	0.55
Consumption Total	39.29	43.40	57.30	84.19	136.0
Difference between Consumption and Pumpage (includes system losses)	4.85	5.36	8.44	9.93	12.12
Pumpage Total	44.14	48.76	65.75	94.12	148.1
Total Baseline Demand[1, 2]	45.39	50.13	67.60	96.78	152.3

[1] Baseline demand amount would equate to raw water diversion at present.

[2] The difference between raw water diversions and treated water pumpage is attributable to several factors including use of some of that water in the treatment process itself, water loss due to evaporation, and metering differences.

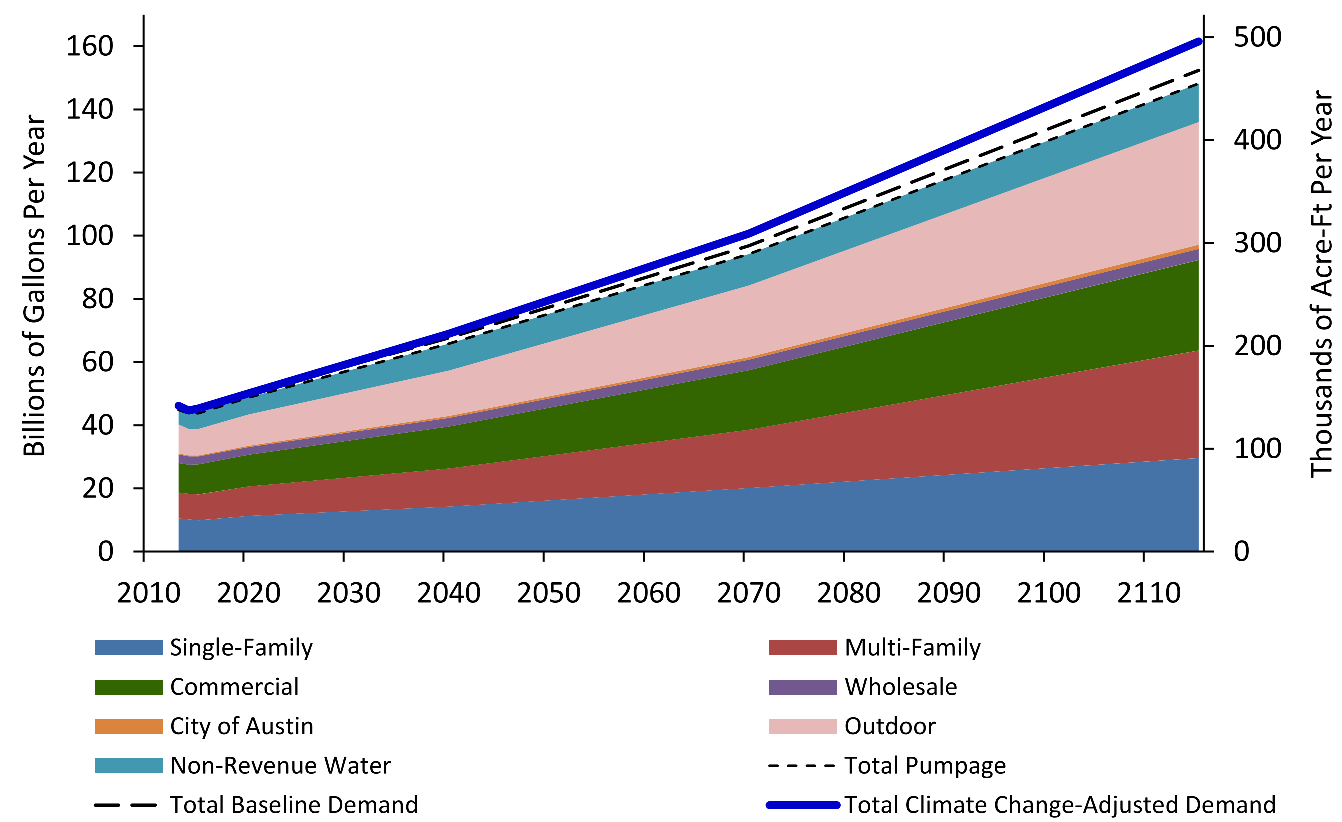


Figure 4-7. Water Forward Baseline Demand Projections by Sector

Figure 4-8., **Figure 4-9.**, **Figure 4-10.**, and **Figure 4-11.**, provide demand schematics for the forecast years. For water demands other than the City of Austin municipal estimates, see **Appendix E**.

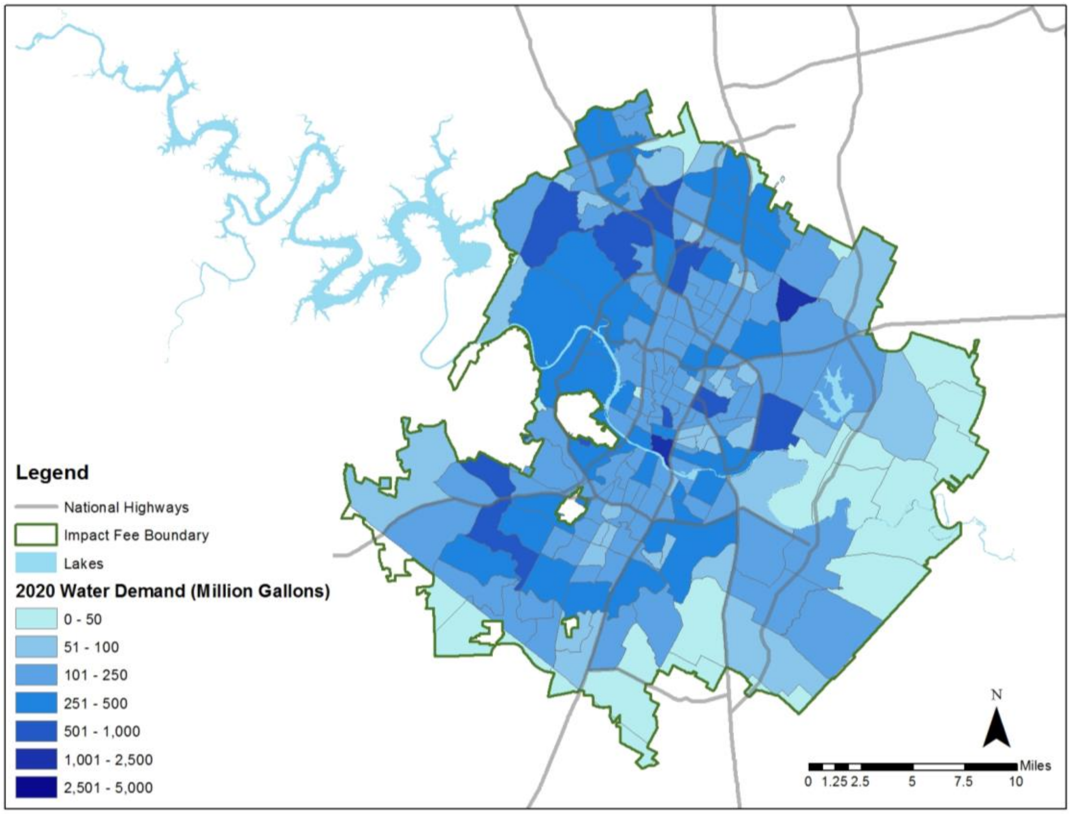


Figure 4-8. Baseline Water Demand Schematic 2020

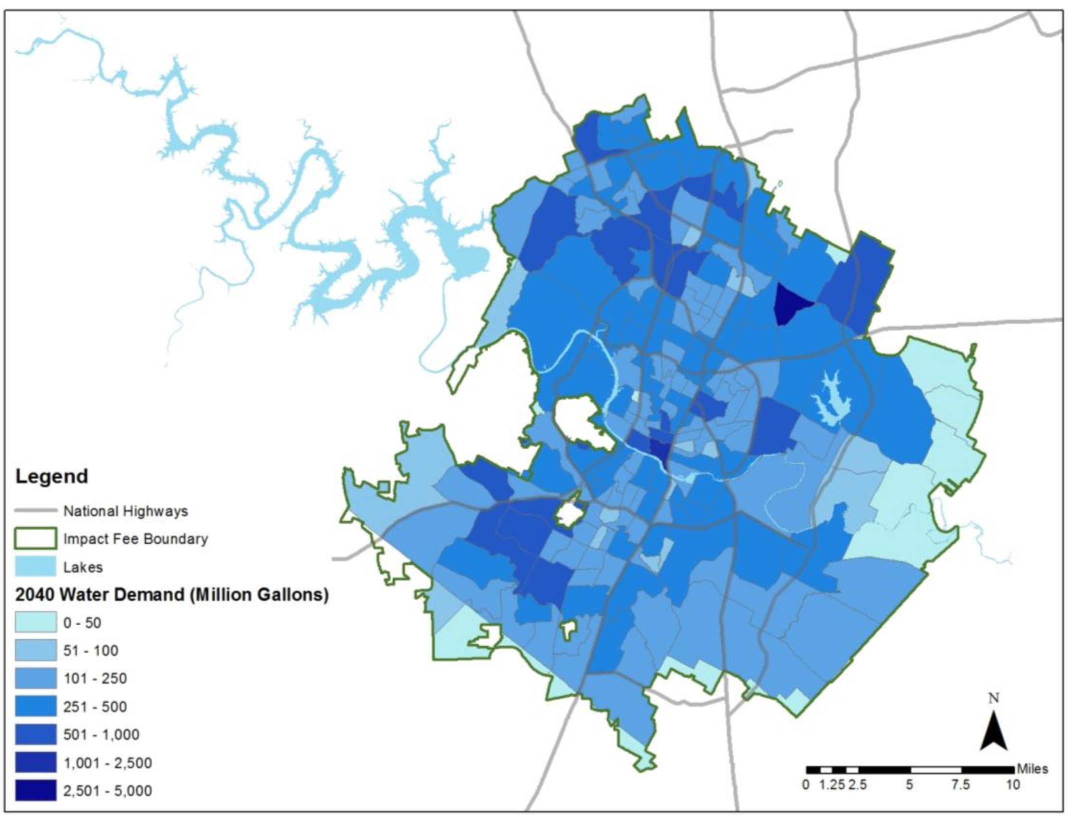


Figure 4-9. Baseline Water Demand Schematic 2040

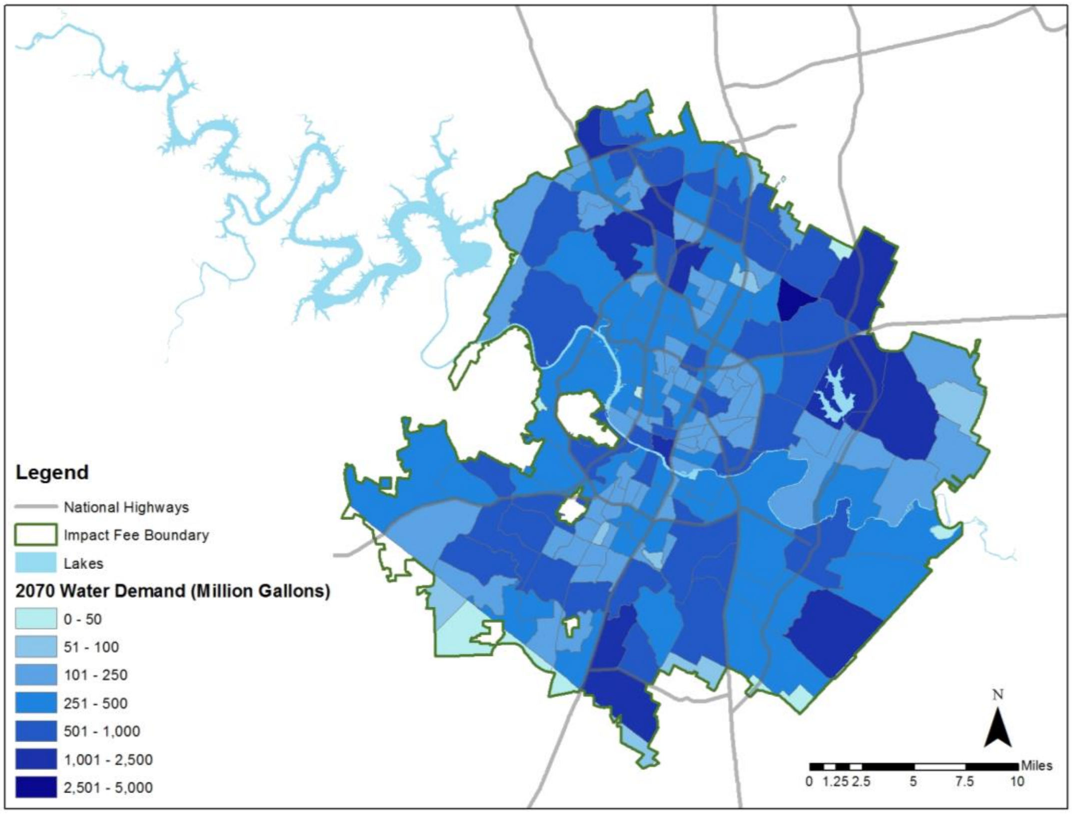


Figure 4-10. Baseline Water Demand Schematic 2070

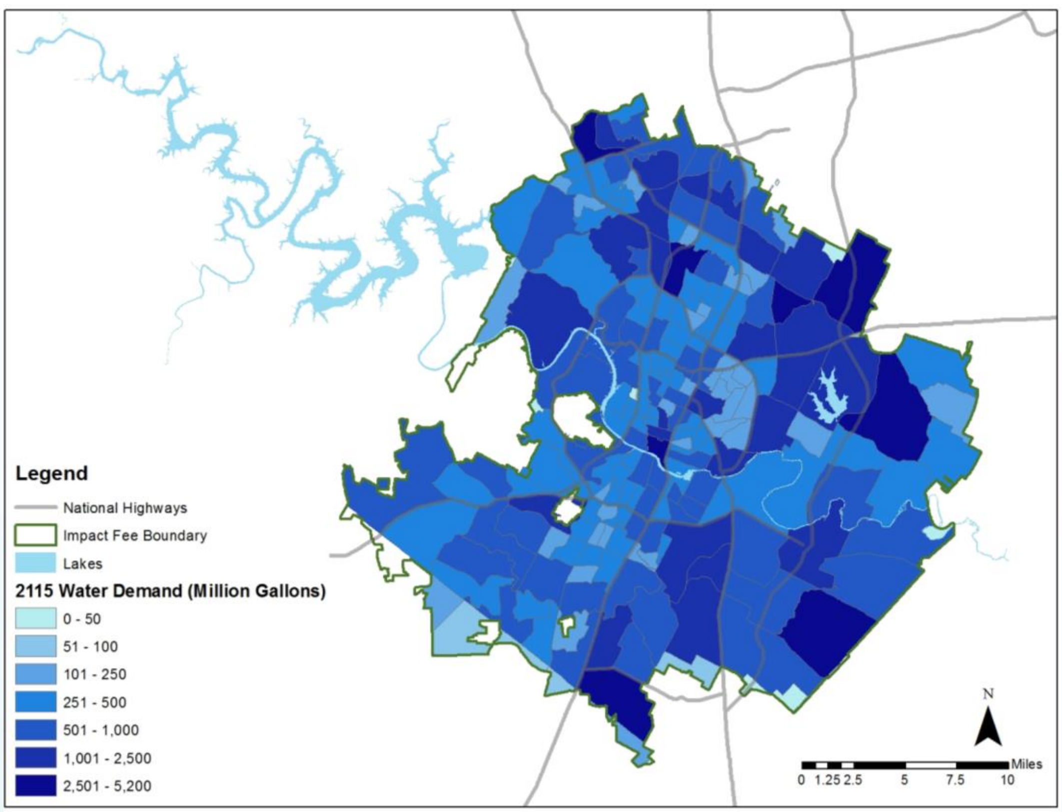


Figure 4-11. Baseline Water Demand Schematic 2115

SECTION 5: HYDROLOGY, CLIMATE CHANGE, AND WATER AVILABAILITY MODELING

As part of the Water Forward effort, the planning process included evaluation of multiple future conditions. Four hydrologic scenarios that considered climate change and droughts worse than the drought of record were developed to use for needs identification and portfolio evaluation. Planning for multiple future conditions allows the planning process to address uncertainties in the future related to possible changing climate conditions or droughts that may be worse than what we have experienced since the 1940s. January 1940 marks the beginning of the period of record for most of the Texas Commission on Environmental Quality Water Availability Models used across the state, and also coincides with the general timeframe when Lakes Travis and Buchanan were constructed and began filling. Using data from this period of record allows planning for a repeat of what has been experienced in these last 77 years. However, an important part of the Water Forward process involved identifying portfolios that aligned with the Water Forward goal of ensuring a diversified, sustainable, and resilient water future. Therefore, hydrology, climate change, and water availability modeling analyses were performed to evaluate a range of possible scenarios to assess the impact of futures which might be different than what we have experienced.

AT A GLANCE

- *Definition of Water Needs*
- *Hydrologic and Climate Modeling*
- *Summary of Water Needs*

5.1 Definition of Water Needs

To guide the development and evaluation of IWRP portfolios, three types of water needs for the City of Austin were identified and assessed:

- **Type 1 Need**: This is a supply and/or conservation savings need equal to the estimated reduction in potable water demand from implementation of the City's Stage 4 Drought Contingency Plan implementation. Stage 4 water restrictions would include a prohibition on all outdoor water use and would be implemented at very low lake levels (for the purposes of the plan analysis Stage 4 is triggered in the water availability model used for the IWRP at or below 450,000 acre-feet of combined storage in Lakes Travis and Buchanan). This need was established to mitigate societal, environmental, habitat, and economic impacts of staying in Stage 4 during prolonged droughts. Both demand management and water supply options can fill this need.

- **Type 2 Target:** This is a potable supply target developed to mitigate the risk of Austin having very little or no Colorado River supply due to severe drought, including droughts that may be worse than what the region has seen in the past. To ensure that Austin would have access to a potable water supply in a severe drought, the Type 2 target was set equal to 50% of the amount of water Austin would expect to receive from Lower Colorado River Authority stored water, whether or not it was actually available in the model (see **Appendix F** for a detailed description of how Type 2 needs were calculated). This target is triggered in the model only when combined storage in Lakes Travis and Buchanan is extremely low (less than 450,000 acre-feet or about 22% full). Only options that can readily provide potable water can fill this need.

- **Type 3 Need:** This is a supply and/or conservation savings need that is triggered when Austin's water demands are above its current 325,000 acre-feet firm water supply contract with Lower Colorado River Authority. Both demand management and water supply options can fill this need.

5.2 Hydrologic and Climate Modeling

Austin Water is using a customized version of the Colorado River Basin WAM as a key modeling tool to determine water availability from the Colorado River. For the IWRP, four hydrologic scenarios were examined to estimate the future water needs, these being hydrologic scenarios:

A. Period of record (1940-2016) with historical climate, often referred to as stationary climate

B. Period of record with climate change

C. Simulated extended period with historical climate (the 10,000 years extended period was developed to evaluate potential droughts worse than the drought of record)

D. Simulated extended period with climate change (the 10,000 years extended period was developed to evaluate potential droughts worse than the drought of record)

5.2.1 Climate Change Modeling

Dr. Katharine Hayhoe, climate scientist with ATMOS Research and Consulting, performed the climate change modeling for the Water Forward process. The work Dr. Hayhoe for Water Forward built on a previous study performed for Austin's Office of Sustainability[5].

Rising temperatures, increased evaporation rates, and an acceleration of the hydrological cycle is increasing the duration and severity of droughts as well as the intensity of heavy precipitation in many places around the world[6]. These and other changes that have been attributed to human-induced climate change are projected to continue over the remainder of this century and beyond. Climate change effects are expected to be pronounced in Texas by the mid-21st century[7]. Summer daily high temperatures are expected to increase, and winter nightly low temperatures are expected to increase as well. Little change in long-term average annual precipitation is expected. However, it is expected that the duration of consecutive dry days will increase in frequency with punctuation by heavy rainfall events.

The Texas Commission on Environmental Quality Water Availability Model (WAM) for the Colorado (River basin includes a historical period of record from 1940 through 2016. The Water Forward WAM contains demand management and water supply scenarios for 2020, 2040, 2070, and 2115. Therefore, to address potential changes to climate in future WAM simulation scenarios, global climate models are used to project hydrologic conditions for 2040, 2070, and 2115. The results of the global climate models form the basis of adjustments to the Water Forward WAM's historical period of record hydrology for these later time

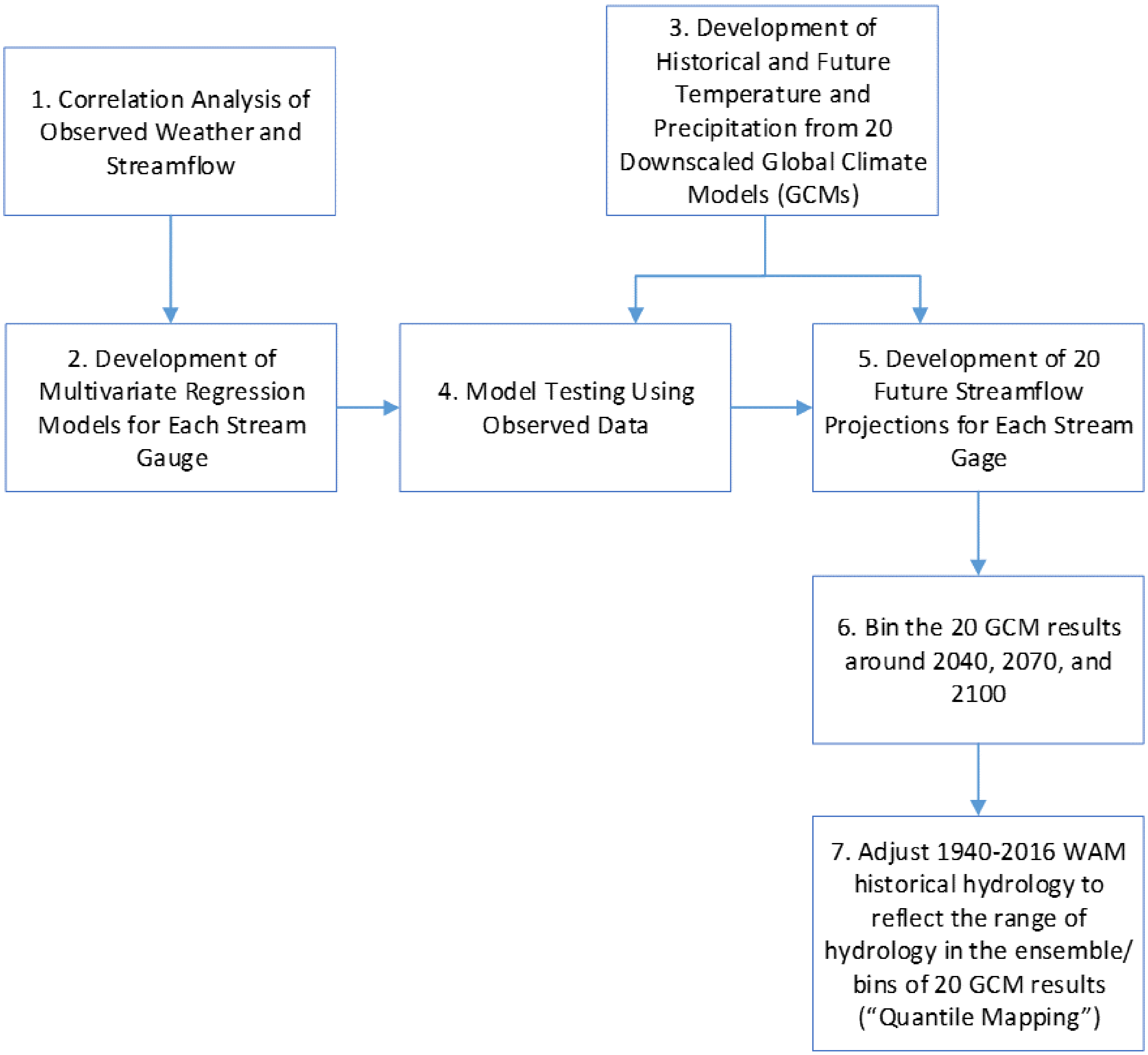
[5] http://www.austintexas.gov/sites/default/files/files/Katherine_Hayhoe_Report_-_April_2014.pdf

[6] IPCC, 2012: Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation

[7] https://austintexas.gov/sites/default/files/files/Katherine_Hayhoe_Report_-_April_2014.pdf

horizons. An overview of the climate change modeling process steps is provided in **Figure 5-1**, and the steps are described further in the following text.

Figure 5-1 Climate and Hydrology Analysis Process Graphic



1. Correlation Analysis of Observed Weather and Streamflow

- Observed daily streamflow at 43 gaging locations in the Colorado River basin were correlated with a large number of weather variables (see **Figure 5-2.**) reflecting variability in observed temperature and precipitation from 1950 through the present.

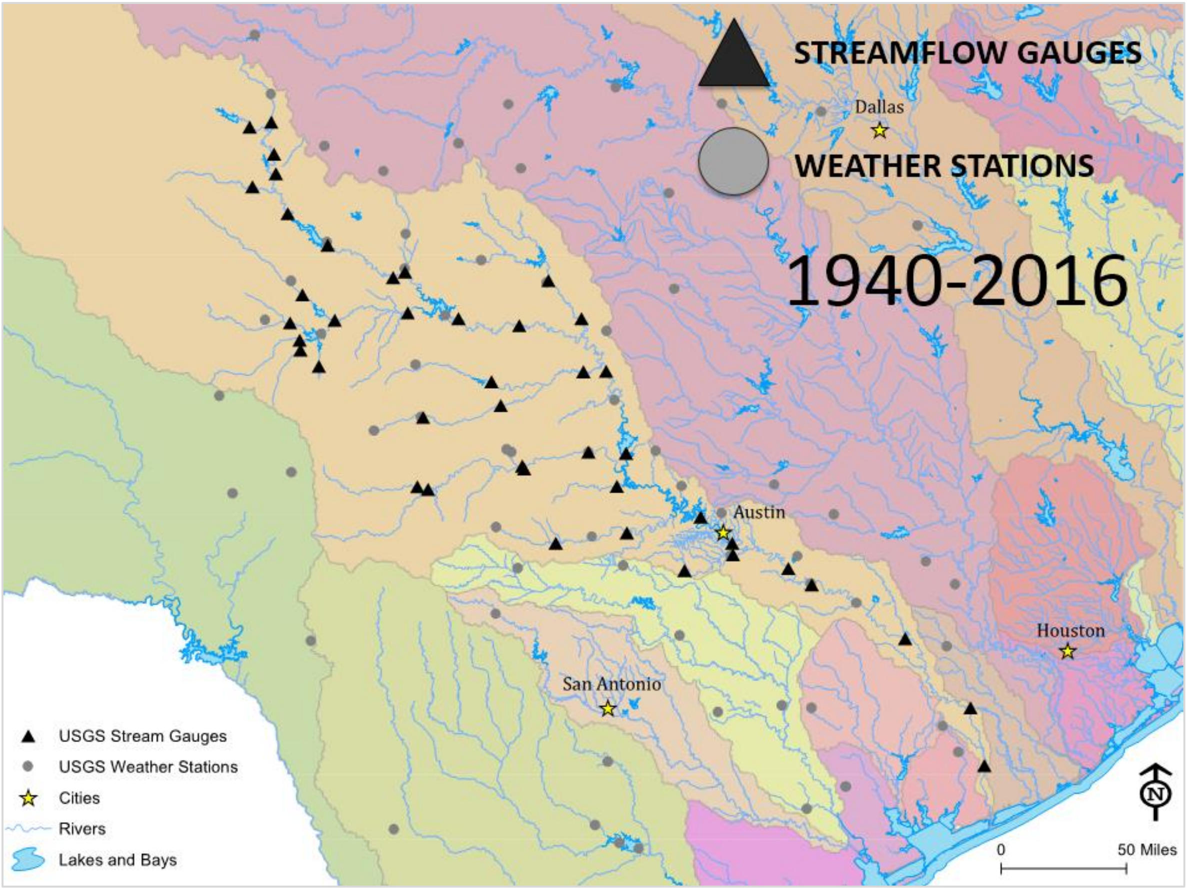


Figure 5-2. Colorado River Basin Streamflow Gages and Weather Stations

2. Development of Multivariate Regression Models for Each Stream Gage

- Statistical regression models of historical streamflow at each gage were built to predict streamflow as a function of the historical weather variables.

3. Development of Historical and Future Temperature and Precipitation from 20 Downscaled Global Climate Models

- Next, high-resolution climate projections of temperature and precipitation from 20 global climate models under a higher and lower carbon emission scenario were downscaled to the same weather stations used to build the statistical models of streamflow at each gage. The higher emission scenario was selected for use in Water Forward as it represents the current trajectory of carbon emissions and serves as a distinctly different outcome of future hydrologic conditions when compared to the historical observations of basin hydrology.

4. Model Testing Using Observed Data

- Each gage regression model was validated on observed data by dividing the historical data in odd and even years, using one set of the data to build the regression model, and the other for cross-validation, then switching. **Figure 5-3.** shows that for these two example stream gage locations, the modelled past and the data observed in the past match fairly well. Additionally, the modelled future is shown for comparison.

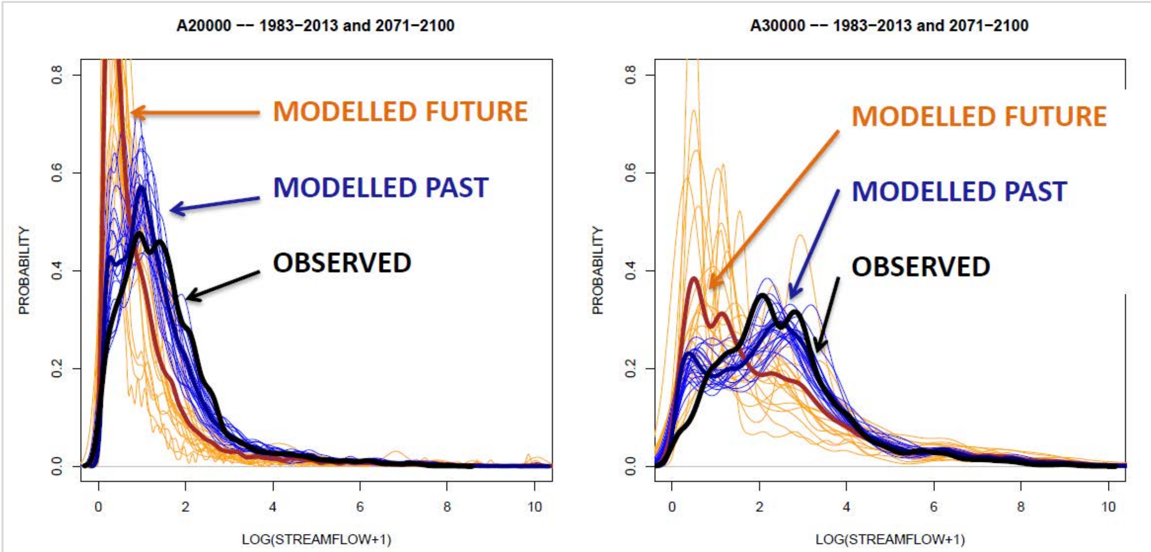


Figure 5-3. Comparison of Observed and Modelled Past and Future Streamflow for a Selected Stream Gage

5. Development of 20 Future Streamflow Projections for Each Stream Gage

The streamflow regression models were driven with the data from the global climate models to create projected streamflow conditions through 2100 (See **Figure 5-4.**). The gage-specific streamflow projections as well as evaporation and precipitation projections were used to develop basin-wide inputs to the Water Forward WAM.

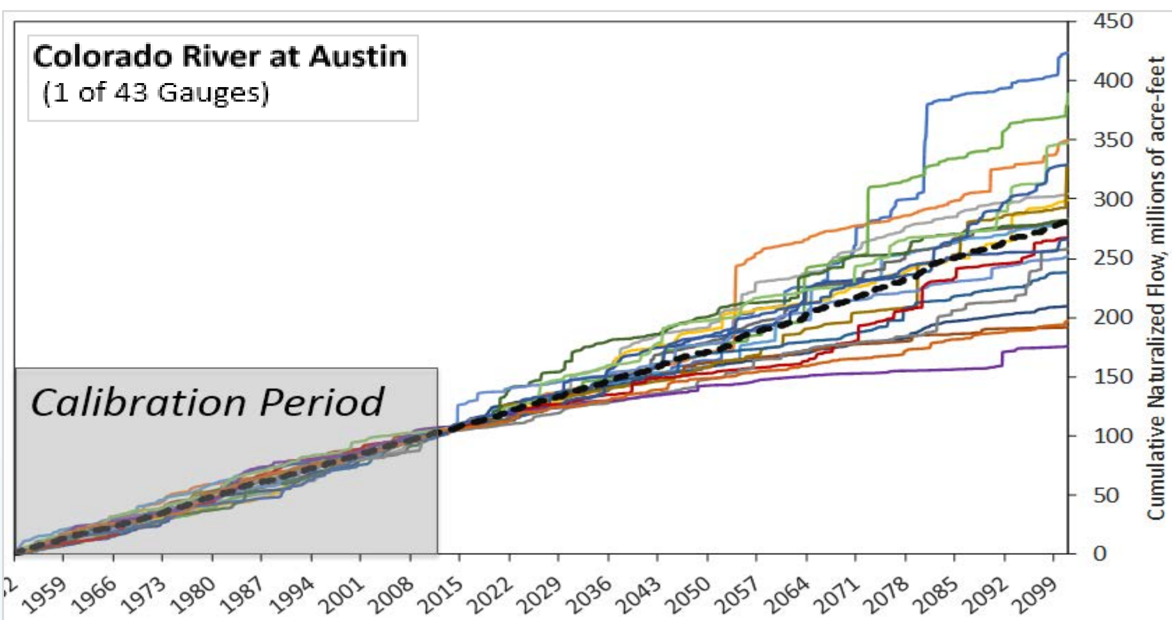


Figure 5-4. Twenty Projections of Cumulative Naturalized Flow for the Colorado River at Austin Gage

6. Bin the 20 Global Climate Models results around 2040, 2070, and 2100

To develop an ensemble of the 20 different streamflow projections, a process was used to compile all the data points for each stream gage from each of the 20 streamflow projections into a "bin." The bins included data output from the streamflow regression modeling grouped into 21-year spans of time centered around 2040 and 2070. Since data from the global climate models were only available through 2100, the bin to collect data points for the 2115 planning horizon was set as the period of projection from 2080 through 2100. The bins of global climate model derived hydrology are as follows: 2030 through 2050 (21 years centered on 2040), 2060 through 2080 (21 years centered around 2070), and 2080 through 2100 (the last 21 years of global climate model results) (See **Figure 5-5.**). Each bin contains downscaled hydrology derived from all 20 climate models which creates 5,040 monthly samples of projected future hydrologic conditions at each gauge.

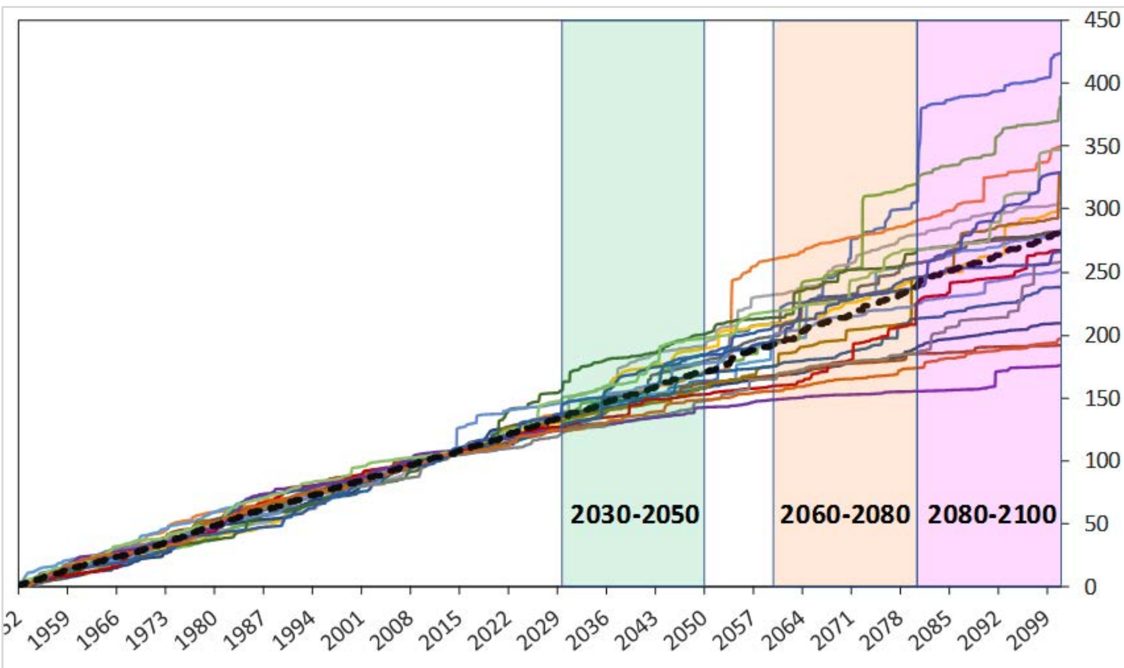


Figure 5-5. Bins Used to Develop Streamflow Ensembles (2030-2050, 2060-2080, and 2080-2100)

7. Adjust 1940-2016 WAM historical hydrology to reflect the range of hydrology in the ensemble/bins of 20 Global Climate Models results ("Quantile Mapping")

Adjustments to the historical period of record hydrology were made using the bins of gage-specific streamflow projections. The statistical characteristics of the ensembles of future hydrology were mapped onto the existing historical period of record at each gaging location in the basin using a methodology known as "quantile mapping" (See **Figure 5-6.**). Quantile mapping has been applied similarly in other long-term future water planning studies (Wood et al. 2002; Salathe et al. 2007; CH2M Hill 2008; Hamlet et al. 2009; Bureau of Reclamation 2010, California Dept. of Water Resources 2013). The statistical properties of the ensemble, such as the mean and variability, are transferred to the adjusted WAM hydrology, evaporation, and precipitation. Only the sequencing of dry and wet periods of the historical WAM hydrology is retained.

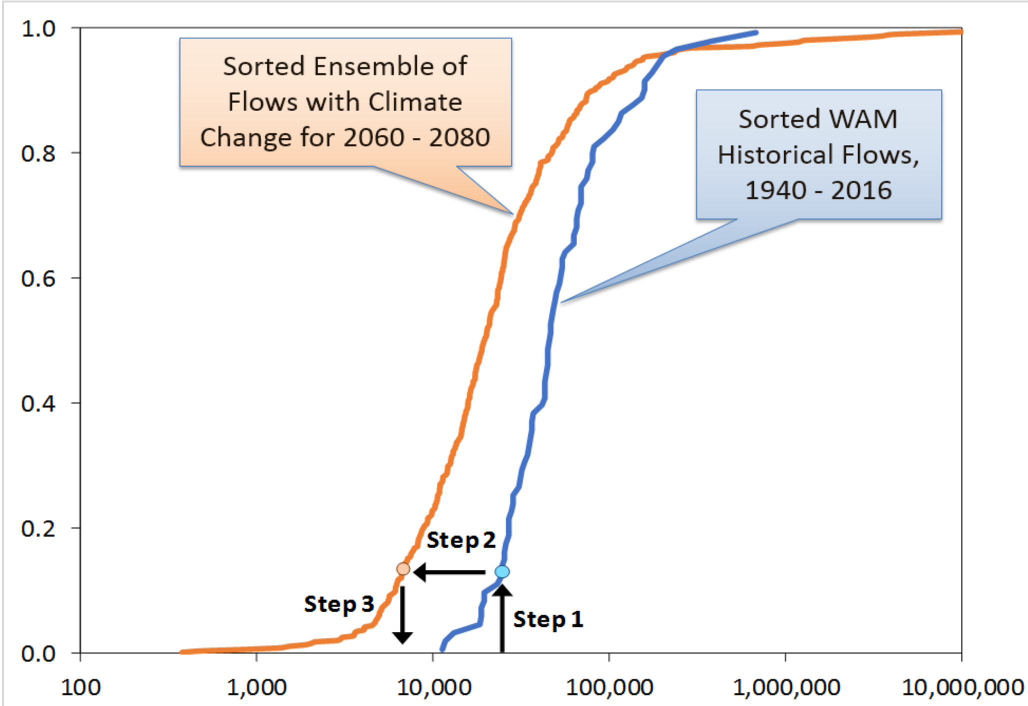


Figure 5-6. Quantile Mapping Process Graphic

To demonstrate the projected impact of climate change, a comparison of annual naturalized flows at the Colorado River at Austin gage with historical hydrology and projected climate changed hydrology is shown in **Figure 5-7.**. The figure shows that total range of flows in the further-out horizons increases as period of low flow increase in duration but are punctuated by extreme flow events. The figure also shows a slight downward trend in annual naturalized streamflow towards the later planning horizons.

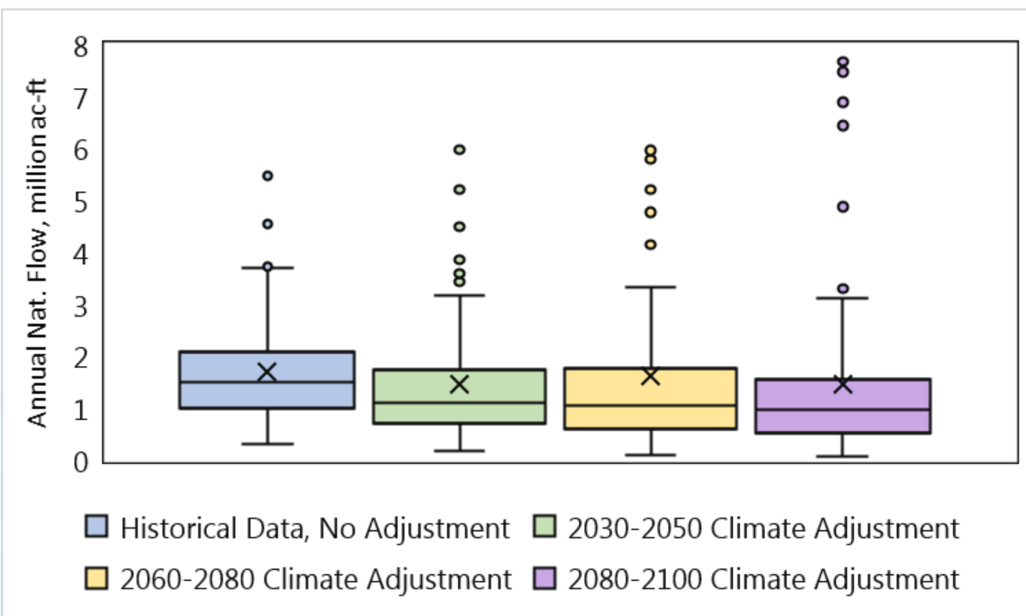


Figure 5-7. Comparison of Annual Naturalized Flows at the Colorado River at Austin Gage

5.2.2 Extended Simulation Period

The historical hydrologic period of record for the Water Forward WAM covers 1940 through 2016. Within the historical period are two major droughts that are centered in the 1950's and 2010's. For the purposes of the Water Forward plan, the 2010's drought serves as a new "drought of record" because the hydrologic conditions result in the lowest modelled water supply from the Highland Lakes reservoirs. A water supply modeling objective of Water Forward is to analyze the impacts of droughts that are worse than the drought of record. Though this worse drought is yet to be observed, water supply planning should anticipate the likelihood of such an event occurring, especially over a 100-year planning horizon and against the backdrop of climatic changes.

The methodology used in Water Forward to create plausible hydrologic conditions for modeling droughts worse than the drought of record involves resequencing the period of record. The methodology is formally known as Monte Carlo Markov Chain sampling. Whole years of hydrology from the period of record are randomly selected and connected back-to-back to build a long and hypothetical sequence of monthly flows. The random sampling is the Monte Carlo component of the methodology, though the sampling is not entirely random. The probabilities of transitioning from wet years to dry years, or dry years to average years, for example, in the long sequence of sampled flows matches the same probabilities in the period of record. Maintaining the same probabilities of transition between years is the Markov Chain component of the methodology. Taken together, the random sampling with adherence to transition probabilities allows for the creation of a long and hypothetical sequence of flows that has the same long-term statistical properties of the period of record.

Using a long sequence of extended hydrologic conditions allows for the random occurrence of conditions that are both wetter and drier than contained in the period of record. Multi-year droughts in the extended hydrology can be worse than the 2010's drought. For example, the 2010's drought is punctuated by high flow events in early 2012 and mid-2015. If random sampling replaced the hydrology of 2012 or 2015 with a drier year in the extended hydrology, then the new drought sequence could be worse than the observed 2010's drought. The extended hydrology used for Water Forward covers 10,000 years of simulation. The length of this simulation is intended to be long enough for random chance to produce a large number of candidate droughts that are worse than the period of record. These candidate droughts are further ranked in the degree to which they are worse than the 2010's drought. Identifying new candidate droughts worse than the drought of record in the extended hydrology and ranking them allowed Water Forward to test water availability in a statistical manner under conditions worse than the drought of record. Only certain droughts worse than the drought of record which had a 20% or greater chance of occurring in a 100-year period were chosen as candidate droughts for evaluation.

5.3 Summary of Water Needs

Using the methodology described in **Section 5.2**, the water needs for the IWRP are summarized in **Table 8-2**. Note that to the extent that "Needs Above Contract" (also referred to as Type 3 Needs) are met by demand management, demand management would need to ramp up over the earlier planning horizons to reach plan targets.

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SECTION 6: WATER CONSERVATION AND DEMAND MANAGEMENT STRATEGIES

Water conservation programs (i.e., demand management) have long been and will continue to be a critical element in Austin Water's management of water resources. Austin Water also continually evaluates its water conservation programs to determine whether they should be modified, phased out, or new programs implemented to achieve evolving conservation goals and to ensure pursuit of cost-effective strategies that reach all customers. This section describes the history of Austin Water's conservation programs and current water conservation measures. The section also describes the candidate future demand management options that were evaluated and considered as part of the planning process. For information on which candidate demand management options were chosen as recommended strategies, see **Section 9-1**.

AT A GLANCE

- *Water Conservation History*
- *Strengthening of Conservation Programs During Drought*
- *Current Water Conservation Measures*
- *Candidate Future Water Conservation and Demand Management Options Considered*

6.1 Water Conservation History

The first water conservation plan was developed for Austin in 1983. That came in response to dangers of demand exceeding treatment capacity after bonds to expand treatment capacity were not approved by voters and the City kept growing. Per capita water use dropped after the City instituted conservation programs, but total water use continued to rise commensurate with the level of growth. In the 1980s and much of the 1990s conservation was seen more as an emergency measure when there was a danger of exceeding treatment capacity.

Over the years, the City's water conservation efforts have evolved into programs designed to reduce both peak-day demand and average per-capita use, reduce system loss, increase reclaimed and alternative water use, focus more on reducing larger outdoor water use, and encourage innovative technologies and methods.

In 1999 the Austin City Council approved a long-term water supply agreement with the LCRA. That agreement featured a conservation incentive that has proven important as the years have gone by. Under the agreement, Austin prepaid $100 million for water. With this prepayment, the agreement specified that Austin will not pay additional amounts for water until the average of the City's diversions from the Colorado River/Highland Lakes for two consecutive calendar years exceeds 201,000 acre-feet. This was projected to occur around 2016 and the City planned to increase conservation to put the trigger off until at least 2021.

In the years following the LCRA Agreement water usage continued to increase with growth. Per capita usage had dropped during the 1980s, but by the mid- ‘90s had reached a plateau. This plateau continued into the early years of the next century.

Then came several turning points regarding water conservation in Austin. In 2005 the Water Conservation Division was moved from the Resource Management Department to Austin Water (then still known as the Austin Water and Wastewater Department). Prior to that time the philosophy had been that the conservation function should not be located within the utility because the utility was focused on selling water rather than conserving it.

As the Water Conservation Division was settling in to Austin Water, the utility revived a long-delayed project, Handcox Water Treatment Plant. The City Council, at public urging, wanted to ensure that absolutely every effort was being made to save water before building a new treatment plant. As a result, in 2006 the Council created the Water Conservation Task Force with the charge of reducing peak day water use. The Water Conservation Task Force consisted of the Mayor, two Council Members and four representatives from City boards and commissions (Water Wastewater, Planning, and Resource Management Commissions and the Environmental Board).

The Water Conservation Task Force, working primarily with Austin Water conservation staff, concentrated on reducing peak load and developed 22 new proposed conservation strategies designed to help meet the Water Conservation Task Force’s goal of reducing peak demand by one percent (%) per year for 10 years.

The Council ultimately decided to move forward with both the task force recommendations and with building Handcox Water Treatment Plant, after moving the site away from the head waters of Bull Creek. The recommendations of the Water Conservation Task Force were approved by the City Council in May 2007. The Water Conservation Task Force recommendations formed the foundation for dramatic drops in water usage in Austin. In 2008, two-day-per-week watering restrictions went into effect, the citizens of Austin responded, and per capita water use began dropping dramatically.

The Council and the community, however, were determined that Austin’s water use drop even faster. In approving the Water Conservation Task Force plan, the Council had created another task force to serve in an advisory role during implementation of the Water Conservation Task Force recommendations. This task force was called the Citizens Water Conservation Implementation Task Force. In 2009 the Council expanded the task force’s role, asking it to recommend additional strategies and programs to increase water conservation. The task force subsequently recommended a goal of 140 gallons per capita per day by 2020. Austin Water and the citizens of Austin embraced that goal and it was achieved several years earlier than the 2020 target, as shown in **Figure 6-1.**

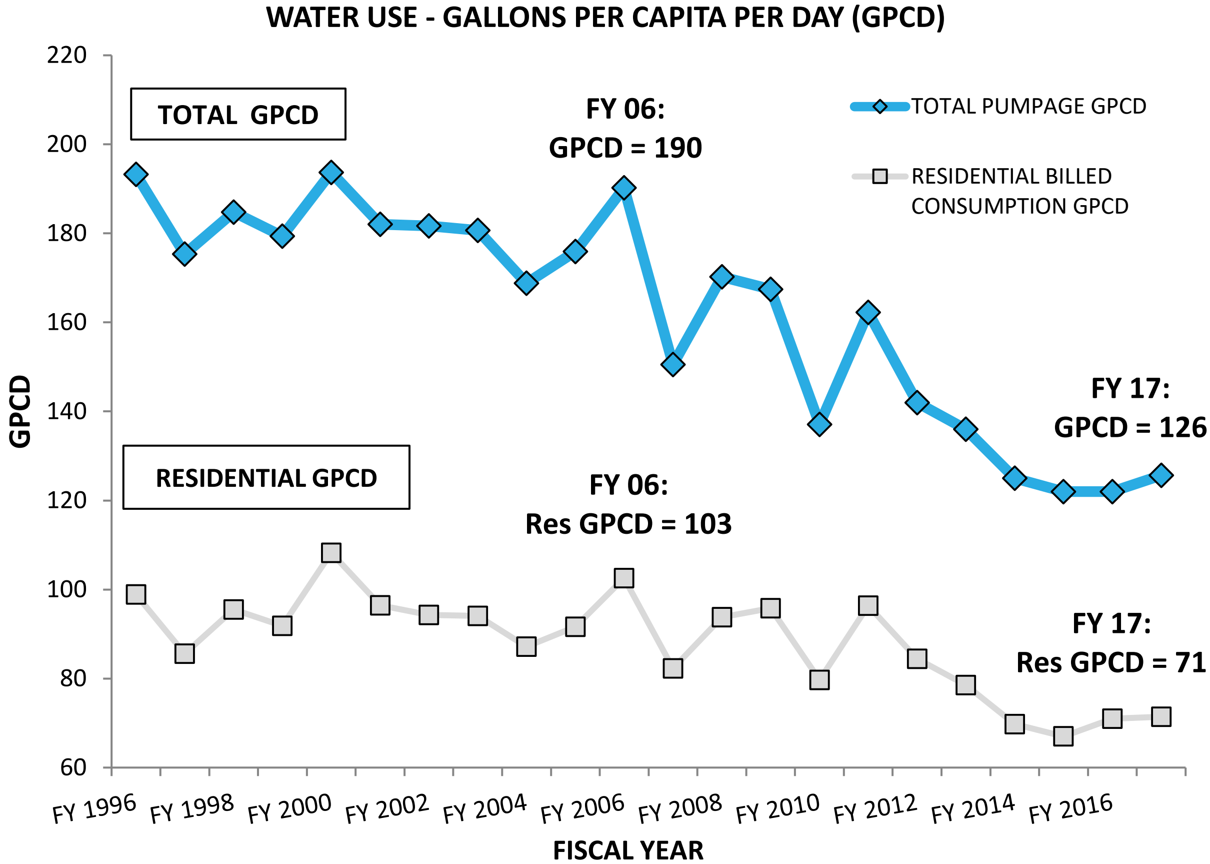

Figure 6-1. City of Austin Water Use in Gallons Per Capita Per Day

Meanwhile the Central Texas region had entered a historic drought, which began in 2008. Based on the lake level triggers in the Drought Contingency Plan Austin went to Stage 2 one-day-per-week watering restrictions in September 2011 and stayed there until 2016 except for a brief City-Manager ordered return to two-day-per-week in 2012. In 2012 Austin strengthened its Drought Contingency Plan.

The drought represents a new critical period for drought in the basin since the lakes were built. Water volume in the lakes reached the second lowest level in history and would have hit the lowest if not for the conservation response of Austin.

The drought was broken by significant rains in 2015 and 2016. The drought, combined with Austin's strengthened water conservation programs, led to historic drops in water usage in Austin. Since the Water Conservation Task Force recommendations were passed, Austin's per capita water usage has dropped 35%. And, even as the City continued its rapid growth, total water use has also dropped. The City now uses less water than it did at the turn of the century, although the population has increased by around 300,000 since then. This is illustrated in **Figure 6-2.**

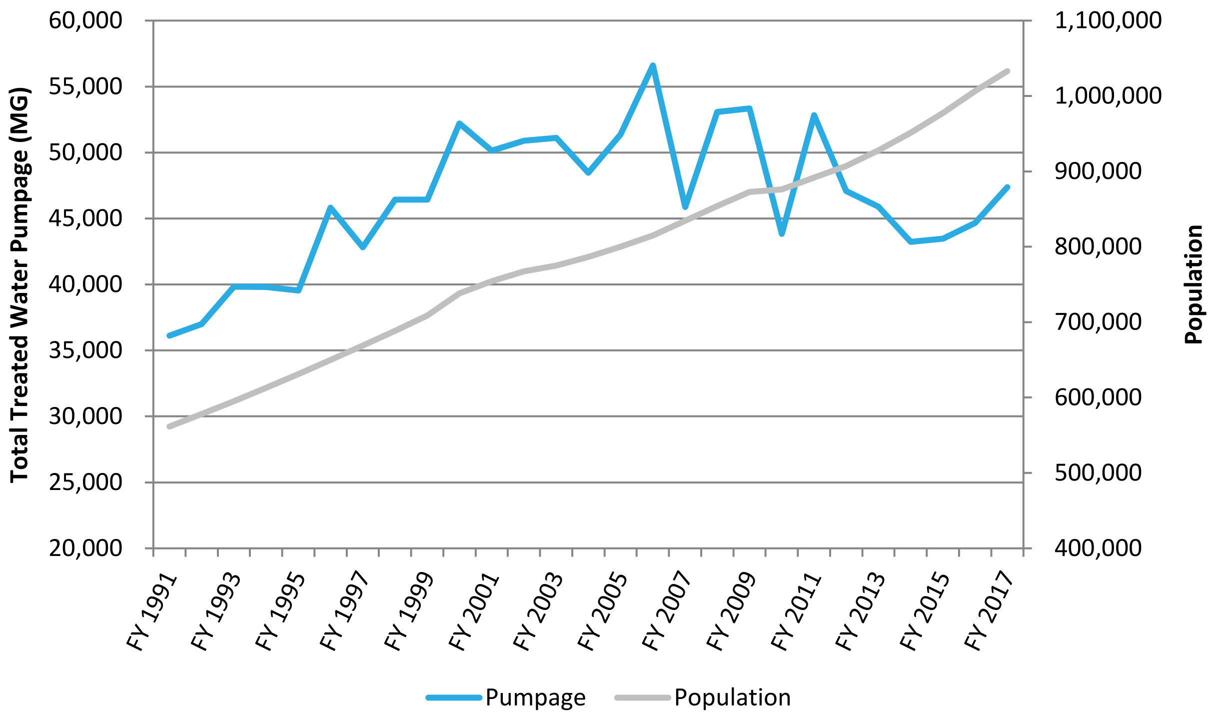

Figure 6-2. Austin's Water Demand and Population

After these water conservation gains, the City is not expected to reach the LCRA payment trigger until the 2030s at the earliest – at least 15 years beyond the original projections. Also, the theory that conservation could not be achieved with the Water Conservation function located within the utility proved to not be the case – as all the dramatic water conservation gains occurred after the transfer.

After the drought was broken, Austin Water worked with the citizens of Austin to ensure that per capita water use would never return to pre-drought levels – as has happened in other places. For example, in 2016 Austin Water proposed and the City Council approved maintenance of one-day-per-week restrictions permanently for automatic sprinkler systems, the least efficient form of irrigation. In Conservation stage, the base stage, hose end sprinklers can be used two days per week.

Building on lessons learned during the drought, Austin Water adopted a permanent one-day-per-week watering schedule for automatic irrigation systems. Watering restrictions proved to be the biggest, most reliable water savings measure and the one-day-per-week restrictions, along with positive community response, were critical in keeping the Highland Lakes above emergency levels during the worst parts of the drought. Permanent one-day-per-week restrictions may also be the most cost-effective, long term water demand management strategy to help Austin meet its future water needs, especially if climate change brings more frequent, severe and longer periods of drought. Using conservation to stretch existing water supplies is significantly cheaper and more environmentally sensitive than developing new water supplies and infrastructure. (For more on the rationale of the watering restrictions and savings see **Appendix G**).

6.2 Strengthening of Conservation Programs During Drought

While watering restrictions are the biggest single water saver, Austin Water expanded or created a variety of conservation programs during the drought years. Some of these efforts were directly attributable to the drought. Others were already underway or developed as part of evolving conservation efforts.

In 2010, the Innovative Commercial Landscape Ordinance was brought forward by Austin Water and Watershed Protection and approved by the City Council. The Innovative Commercial Landscape Ordinance serves as both a water quality and conservation tool. As a change to the land development code, it requires new commercial developments to direct stormwater to an area at least 50 percent of the size of the required landscape. Means for conveying stormwater to landscapes vary and range from passive to active methods, several of which can count towards receiving water quality credit. In an effort to limit non-essential irrigation, commercial customers may now choose whether to install permanent irrigation in the peripheral regions of the property, and undisturbed vegetation will count towards the “50 percent requirement.”

In 2012, as part of intensified drought response efforts, Austin Water worked with the community, including the car wash industry, to require commercial car washes to meet water efficient equipment standards. Commercial, multi-family, and city municipal facilities with vehicle wash equipment that uses potable water from Austin Water must submit an annual efficiency evaluation. A plumber licensed by the State of Texas must perform the evaluation. Only certified car wash facilities are authorized to operate.

Then in 2014, commercial, multi-family, and city of Austin properties one-acre in size or larger were required to complete an irrigation system inspection every two years. The inspection must be done by an Austin Water authorized Irrigation Inspector.

Also in 2014, Austin adopted several changes to city codes and ordinances to facilitate the use of auxiliary water (e.g., rainwater, gray water, reclaimed water, A/C condensate) while still protecting public health and safety, and consistent with state law. The changes were the result of a two-year evaluation that included input from a special task force, the public, and a consultant hired by the city to review these codes recommend changes. Changes included removing unnecessary impediments to the use of alternative onsite and reclaimed water in conjunction with changes to relax backflow protection and permitting requirements for these systems. Code changes also included the mandatory reclaimed water hookup and the installment of AC condensate recovery and use systems for new commercial and multi-family facilities as well as the reuse of cooling tower blowdown water and use of AC condensate for cooling tower makeup water. As a part of implementing these changes, Austin Water developed technical guidance documents for residential and commercial onsite alternative water use systems to help customers install systems consistent with the new provisions and take advantage of available rebate programs and code requirements.

In addition, Austin Water provided comments in support of state legislation in 2015 (HB 1902) and related changes to Texas Commission on Environmental Quality rules contained in 30 Texas Administrative Code 210 adopted in December of 2016 to further facilitate the use of all auxiliary waters, including industrial reclaimed wastewater.

Austin required, beginning in 2015, new commercial developments or redevelopments within 250 feet of a reclaimed water main to connect for irrigation, cooling, and other significant non-potable water uses. Reclaimed water is treated wastewater and is about 20% of the cost of potable water. Those facilities that are “purple pipe” ready can begin to take advantage of the reduced rates, even before the reclaimed water line has reached their location. The reclaimed water initiative is an integral part of the City’s water conservation program and saves on average about 1.2 billion gallons of drinking water a year.

Austin Water also has some decentralized wastewater treatment plants and a program to consider and evaluate the use of decentralized and on-site wastewater systems in appropriate situations, including for golf course irrigation.

While the conservation measures discussed in this subsection so far are regulatory in nature Austin Water also worked to strengthen voluntary programs as well. For example, in 2015, Austin Water worked with the Home Builders Association of Greater Austin and other local entities in developing and publishing “Sensible Landscapes for Central Texas – A Guide for Home Builders and Homeowners.” This guidance document includes landscape design, regionally appropriate plant selection, landscape and soil management as well as irrigation design and maintenance for home builders and owners for water efficient lawns and landscapes suitable for the Central Texas region. The guidelines include limiting the amount of unnecessary sod and water-intensive plants commonly included in builders’ landscaping packages, and instead, offering more sustainable and environmentally sensitive native and adapted species as an option for homeowners. All Home Builders Association of Greater Austin members have adopted these guidelines and provide this landscape option to new home buyers.

A related, longer running program is Grow Green. It is a partnership between the City of Austin and the Texas AgriLife Extension Services, offers fact sheets with landscaping, design, installation, and maintenance recommendations to promote low-water use landscapes. It also provides a Native and Adaptive Plant Guide with information about plants that thrive in the Central Texas climate. Austin Water uses this plant guide in approving suitable plants for its landscape conversion incentive programs.

Continuing to build its conservation efforts after the drought, in 2017, Austin Water launched the Cooling Tower Water Efficiency Program, which includes registration and annual inspection requirements. These actions bring increased awareness of cooling tower requirements, use efficiency, and savings. The program assists in identifying potential water conservation upgrades, promotes reclaimed and alternative on-site sources of water for cooling tower make-up and other non-potable water demands, calls attention to innovative cooling systems that use less or no water, and pinpoints rebates and incentive opportunities. By obtaining baseline information on the number, size, type, water source, and water efficiency compliance requirements, the program aims to assess the effectiveness of the city’s cooling tower requirements and identify any needed code or program modifications.

Cooling tower water efficiency standards and equipment requirements have been in place in Austin since 2008. At the time of adoption, it was estimated they would save about 100 million gallons per year—enough to serve 1,500 households, and save approximately $1.6 million per year in water and wastewater charges. Additional incentives and requirements to use reclaimed and alternative on-site sources of water could further reduce potable water demand and its associated costs.

In 2017 the region experienced a dry year and 2018 has been relatively dry as well, meaning the area could be entering another drought. It is such events that Austin’s Drought Contingency Plan, its water conservation programs, and the Water Forward plan are intended to address. With one of the most extensive water conservation programs in the nation, Austin plays a leadership role in conservation at the regional, state and national levels, and shares experiences and resources with other water providers to promote conservation innovation and effectiveness. This includes but is not limited to:

- participating in Senate Bill 1 regional planning efforts to meet future water needs in the lower Colorado River basin (Region K);
- developing best management practices and legislative recommendations for the state Water Conservation Advisory Council;
- developing new water supply and reuse strategies through the City of Austin/Lower Colorado River Authority Water Partnership;
- sharing ideas and information among Central Texas Water Efficiency Network members;
- exchanging information with other LCRA Firm Water Customers and providing comment to LCRA on its water supply management and contract programs;
- partnering in research and studies with other entities around the nation under the auspices of the Water Research Foundation and Alliance for Water Efficiency; and
- enhancing programs through education, training and presentations given at conferences and events of the American Water Works Association.

Austin has been engaged in regional partnerships for quite some time and its programs are often emulated by surrounding communities.

Austin Water's conservation program has received numerous awards over the years from state and national organizations. Awards received just within the last five years include:

- 2013 Promising New Program from the American Council for an Energy Efficient Economy and the Alliance for Water Efficiency;
- 2014 Water Conservation and Reuse Award, Texas Section of the American Water Works Association
- 2014 Municipal Blue Legacy Award in Municipal Water Conservation, Texas Water Conservation Advisory Council
- 2015 Municipal Blue Legacy Award in Municipal Water Conservation, Texas Water Conservation Advisory Council; and
- 2016 highest scoring water conservation program in Texas, Texas Living Waters Project (Lone Star Chapter of the Sierra Club, the National Wildlife Federation, and Galveston Bay Foundation).
- In July 2018, Austin Water's conservation programs achieved Platinum certification on the Alliance for Water Efficiency's G480 Leaderboard. The Alliance's grade of Platinum certifies that Austin Water is in 100% compliance with all recommended best practices for an effective conservation program. With this certification, Austin Water became only the fifth agency in the nation to complete the rigorous certification process, only the third to achieve Platinum certification, and the largest participating agency to date.
- The G480 standard (Water Conservation Program Operation and Management) is part of the American Water Works Association's G-series of voluntary management standards that

demonstrate outcome-oriented practices and policies that go above established regulations and set a benchmark for excellence. As an independent industry advocate, the Alliance for Water Efficiency evaluates submissions from member agencies to award a platinum, gold or silver certification that shows the degree of compliance with AWWA's G480 standard.

An overview of Austin's water conservation incentive programs including those implemented during the early years are summarized below in **Table 6-1.**

Table 6-1. Summary of Historical Austin Water Conservation Incentive Programs

Water Conservation Program	Equipment or Service Issued	Program Description	Implementation Date /End Date
Landscape Irrigation Audits	Free Audit and hose timers	The City offers free landscape irrigation audits to both residential and commercial customers who water excessively outdoors. In 1998, the City offered free hose timers to customers who irrigated with hose-end sprinklers.	1985 since modified and still in effect
Toilet Rebate Program	Rebate for Ultra-low flush[1] toilets	The City offered a rebate to residential customers to encourage replacing old toilets with Ultra-low flush[1] models. The program initially offered a rebate of $60-$80 per toilet then increased to $200 per toilet depending on the model purchased.	1991 through June 2010
Free Toilet Program	Free Ultra-low flush[1] toilets	The City offered the Free Toilet Program to encourage the replacement of older less efficient models with Ultra-low flush[1] models. This program was initially limited to low income residential customers, but was expanded to all residential customers, multi-family and commercial customers.	1994 through December 2011
High-Efficiency Washing Machine Rebate Program	Rebate for high-efficiency washing machines	The City offers the High-Efficiency Washing Machine Rebate for water-and-energy efficient washing machines identified by the Consortium for Energy Efficiency. The initial rebate was for $100 but was lowered to $50 in 2010.	1998 through 2013
Industrial, Commercial, and Institutional Rebate/Bucks for Business	Free audit	The City offers a free service to commercial customers, where water conservation staff auditors would evaluate a business' water consumption and use and suggest ways to reduce water use.	1996 since modified and still in effect
Rainwater Harvesting Rebate/Rain Barrel Sales	Rebate for rain barrels	The City offers rebates for rainwater harvesting, which included a $30 rebate for purchasing approved rain barrels and rebate of up to $500 for implementing higher-volume pressurized rainwater systems. In 2001, the Water Conservation Department started to supply barrels to its customers at a reduced and subsidized price of $60 per barrel. The Rain Barrel Sales Program ended in 2009.	2000 since modified and still in effect
Xeriscape Program/Water Wise Landscape	Rebate for using native plants and turf grasses	The City initially launched an education program to promote the principles of Xeriscaping to emphasize the practice of using plants there were native or adapted to the climate in order to reduce or even eliminate the need for irrigation. In 1994, the program was modified, and a residential rebate was initiated to encourage the installation of plants and turf grassed that were better adapted to the climate.	1984 through 1998
Residential Landscape Conversion Incentive - Lawn Remodel Option	Rebate to replace turf with Bermuda or Buffalo grasses	The City offered residential customers a one-time opportunity to replace water-thirsty turf with Bermuda or Buffalo grasses. Rebates for this program ranged from $10 to $30 for every 100 square feet of turf converted.	October 2011 through September 2013
Restaurant Water Waste Program	Free audit and 1.6 gallons per minute spray valves	Water Conservation Department staff members preformed water audits for restaurants and replaced old spray valves with new 1.6 gallons per minute valves.	2004 through January 2006

[1]Ultra-low flush toilets use 1.6 gallons per flush or less

6.3 Current Water Conservation Measures

Austin Water achieves water conservation progression through the passing of codified ordinances and a variety of programs implemented through the Water Conservation Division, including, but not limited to: rebates for water-saving equipment; dispersion of free equipment; and activities aimed at increasing public education on the importance of water conservation. The following section provides an overview of current water conservation measures; a more comprehensive summary can be found in **Appendix G.**

6.3.1 Cost-Benefit Methodology and Integration into Water Resource Planning

This section includes an overview of Austin Water's current water conservation cost benchmarks and cost-benefit methodology. With the information developed as part of the Water Forward planning process, Austin Water plans to develop updates to the performance benchmarks and cost-benefit methodology.

Austin Water generally funds the water conservation programs from their annual Operation and Maintenance (O&M) budget through rate revenues collected. Due to the state's cost-of-service requirements for public utilities (see Texas Water Code §§13.182, 13.183, and 13.184), Austin Water generally uses the utility cost-benefit approach when issuing money from customer revenues to private individuals, rebate amounts are based on a direct, quantifiable, and comparable benefit to rate payers of the utility. The utility cost-benefit approach is commonly used by major municipal utilities[8].

Benefits to the utility rate payer from funding conservation rebate programs include reducing cost of service increases due to increased water/wastewater treatment and distribution costs and delaying the cost of securing additional water supplies in response to growth. Programs with a less than favorable quantifiable cost-benefit ratio may still be used on a temporary or pilot basis to evaluate new or innovative technology, penetrate hard-to-reach markets, increase public awareness, or achieve water savings faster in response to drought or other water shortages.

Austin Water quantifies and documents actual or estimated water conservation cost/savings for its various water conservation measures and incentive programs to determine their potential cost-benefit of achieving the City's conservation goals. This includes the development of digest summaries for each program and use of the Alliance for Water Efficiency Conservation Tracking Tool to measure and track the program's effectiveness in meeting these goals. The estimated water savings are not only based on national and state studies (i.e. EPA, Water Research Foundation, Alliance for Water Efficiency, Texas Water Development Board), but heavily reference specific local information. These digests are continually updated as new information becomes available or to reflect changes in the program and/or the City's codes and ordinances. Information from the digests is also used to determine whether to add, modify, or terminate a program. Depending on the study or research conducted in the Austin area, the digest information is ranked according to confidence level, which determines how frequently the information needs to be reviewed and updated. Factors considered by Austin Water when developing a rebate program typically include whether the program achieves following:

- Helps achieve the utility's quantified or qualitative conservation goals;
- Acts as an incentive to get customers to do what they otherwise would not have done without the rebate, rather than simply subsidizes a business or customer sector;

8 "Utility Benchmark Comparison." October 2018, prepared by Susan Roth Consulting for City of Austin, Austin Water.

- Provides comparable value to the utility in terms of reduced or avoided costs related to water and wastewater treatment and distribution and development of new supply;
- Is cost-effective to the utility and the customer;
- Gathers needed data on new and innovative technology;
- Facilitates access to limited or hard-to-reach markets;
- Protects water quality and the environment; and,
- Increases public awareness on the need to conserve.

Austin Water evaluates many aspects of encouraging water efficiency, including rebates, tax incentives, free high efficiency plumbing fixtures, behavior modification tools (i.e. 'smart' meters) and related customer portals, as well as the public relations value to the customer. Coordination with other incentive programs offered for economic development or energy conservation also significantly enhances the effectiveness of the program.

Since the 1980's, Austin Water has used integrated water resource planning concepts to evaluate and prioritize water supply options based on the most cost effective, environmentally sensitive strategies. Austin has effectively used water conservation as a strategy to delay and reduce additional water supply contract costs.

Recently, the utility's focus has been on short-term incentives for new water-saving technology and comprehensive changes that have greater water savings, rather than on providing smaller residential rebates. Austin Water developed regulations that embed conservation into new development requirements and discourage excessive water use, created programs targeting high water users, and continues marketing efforts to increase consumer awareness of water use patterns and choices. The utility also conducts pilot projects and participates in national research projects to identify future conservation strategies and savings potential.

The rebate programs and financial incentives are tied to specific conservation goals, such as the reduction of peak-day demand from outdoor usage that results in increased treatment capacity and distribution costs, or reducing average-day demand (year-round indoor and commercial use) to avoid the costs of developing additional, long-term water supplies. Based on 2010 information, Austin Water has calculated the cost in terms of net present value for constructing additional treatment and distribution, which is approximately $4.00 per 1,000 gallons and $0.64 per 1,000 gallons, respectively. As a result, the rebate amount seeks to 'purchase' a comparable benefit from the conservation measure to the rate payer to avoid these costs. Austin Water periodically updates these goals and costs through its integrated water resource planning efforts.

Austin Water's conservation measures and programs are intended to address the following goals:

- Reducing peak daily demand by one percent per year over a ten-year period or by 22 million gallons per day (MGD) by 2017;
- Reducing average per capita water use to no more than 140 gallons per capita per day (GPCD) by 2020;

- Delaying the annual average use of 201,000 acre-feet of water for two consecutive years to avoid triggering additional payment under the 1999 Lower Colorado River Authority (LCRA) water agreement;
- Reducing summer peaking factor at or below 1.5 by 2035;
- Promoting innovation in water conservation while pursuing cost-effective strategies; and,
- Maintaining an Infrastructure Leak Index below 3.0.

Austin Water has already surpassed a number of their water conservation goals. Austin Water has exceeded the peak day reduction goal of one percent per year and reached a five-year rolling average per capita water use of 126 GPCD in 2017. The utility lowered its average per capita water use to 140 GPCD within three years of adopting the 140 Plan and further decreased the consumption to less than 140 GPCD in 2014. In addition, the 2014 Austin Water Resource Planning Task Force was created by City Council in April 2014 to evaluate the City's water needs, to examine and make recommendations regarding future water planning, and to evaluate potential water resource management scenarios for Council consideration. A key recommendation of the 2014 Task Force was the development of a new integrated water resources plan.

6.3.2 Conservation-Oriented Tiered Rate Structure

To keep costs affordable for essential uses and discourage excessive use, Austin Water has a five-tiered inclining block rate structure for single-family residential customers. Water rates for commercial and multi-family customers do not increase with the volume of water used; however, these customers have peak and off-peak rates to encourage seasonal conservation. Wholesale customers and several large volume/industrial customers have individual rates established through negotiated contracts.

Austin Water has one of the steepest inclining block residential rate structures in the country, which has resulted in a dramatic reduction in the amount of water sold at the highest tiers. This, along with revenue stability fees, have helped Austin Water maintain revenue stability during drought when water demands are reduced by additional restrictions while still allowing customers to save money by reducing water use.

6.3.3 Ordinances

Austin’s water conservation ordinances apply to commercial businesses and residences throughout the city. A comprehensive chronology of Austin’s water conservation codes and ordinances adopted from 2007 through 2017 follows.

2007

- Automatic irrigation systems prohibited from watering between 10:00 a.m. and 7:00 p.m. year-round.
- Allowed no more than two times per week residential watering from May thru September; commercial watering is permitted year-round.

2008

- Submeters required in new multi-family and mixed-use facilities.
- High-efficiency urinals using 0.5 gallons per flush required for new construction and retrofits.

- Commercial food waste and garbage disposal units prohibited.
- Liquid ring surgical and dental vacuum pumps prohibited.
- New or replacement cooling towers must achieve at least five cycles of concentration and have conductivity controllers, makeup and blowdown meters, overflow alarms, and drift eliminators.
- Car wash equipment efficiency and facility certification requirements.
- Automatic irrigation system design standards for new commercial and multi-family residential properties.
- Commercial landscape soil depth and plant requirements adopted.

2009

- Fifth tier residential water rate for use above 25,000 gallons per month.

2010

- High-efficiency toilets using 1.28 gallons per flush or less required for facilities built or renovated on or after October 1, 2010; waterless urinals allowed.
- Innovative Commercial Landscape Ordinance requiring new commercial developments to capture storm water to prevent runoff and for landscape irrigation.

2011

- Stormwater retention and irrigation required for new commercial properties.

2012

- Year round two times per week watering schedule for all customers.
- Morning automatic irrigation system watering times reduced to a window from midnight to 5:00 a.m.
- Mandatory reclaimed water hook-up.
- Graywater Allowances.

2013

- Revised rate structure to compress residential rate tiers including 5th tier to now apply to residential use above 20,000 gallons per month.
- Mandatory irrigation system audits every two years for commercial/multi-family/city properties over one acre.
- Mandatory annual vehicle wash facility efficiency assessment for commercial, multi-family and city facilities and related efficiency requirements.
- Administrative enforcement process/penalties for water use violations.
- Requirement that water be served only at the customer request at restaurants.

- Hotels must have towel/linen exchange programs.

2016

- Year-round watering one time per week for automatic irrigation systems.

2017

- Requirement to install air conditioning (AC) condensate collection systems for new commercial and multi-family development with a combined cooling capacity equal to or greater than 200 tons.
- Require registration and inspection of all cooling towers using potable water to ensure that affected cooling towers are achieving a minimum of five cycles of concentration, have makeup and blowdown sub-meters, a conductivity controller, a drift eliminator, and an overflow alarm. Also ensure that new towers of 100 tons are greater are connected to the Building Energy Management System or Utility Monitoring Dashboard and either using reclaimed or onsite alternative sources such as AC condensate as a part of their makeup water or are beneficially reusing blowdown water.
- Require all steam boilers to have conductivity controllers to control blowdown (for 50 horsepower or greater, this must be connected to the Building Energy Management System or Utility Monitoring Dashboard), a cold-water make-up meter, a steam condensate return system, and a blowdown heat exchanger to transfer heat from blowdown to the feed water.
- Adopted plumbing requirements consistent with the 2015 International Residential Code for residential facilities and the 2015 Uniform Plumbing Code for commercial facilities with local amendments including 1.28 gallons per minute for commercial kitchen pre-rinse spray valves instead of the current requirement of 1.6 gallons per minute.

6.3.4 Proactive Enforcement

In 1983, the City of Austin enacted its first water use management ordinance, which implemented watering restrictions in response to treatment system constraints. In 2001, the City enacted a permanent water waste prohibition making it a Class C misdemeanor (max. $500 fine) to waste water through poorly designed irrigation systems or fail to repair leaks. At that time, Austin Water added enforcement staff to make regular patrols and field inspections to actively enforce water use ordinances. In 2012, Austin enacted administrative penalties to be assessed on water bills after notice and opportunity for an administrative hearing to streamline the enforcement process without the need to go to municipal court.

Austin Water implements and enforces a comprehensive Water Conservation Code (Chapter 6-4 of City Code) that applies to all customers. The goal of this code is to balance conservation of the water supply with the desire to sustain the local economy and the natural surroundings, tree canopy and vegetation, that are unique to Austin. One of its largest water savings measures is a year-round restriction that limits use of automatic irrigation systems to no more than once a week and hose-end sprinklers to no more than twice a week.

6.3.5 Residential Customer Programs

Austin Water currently offers a variety of free indoor and outdoor conservation tools and rebates to help residential customers save water. These free include: water-efficient showerheads, kitchen and bathroom faucet aerators, soil moisture meters, water saver hose meters, and sunlight calculators. Rebates and programs offered by Austin Water include:

- "Controller 101" Workshops – Residential customers may attend a free hands-on workshop to review how irrigation controllers work and find out about hidden features and options that can help save water and money.
- Dropcountr - Free home water use reports available by mobile app and/or by internet can help save customers water and money by providing historical water use and rate tiers, comparisons to similar and efficient homes, water saving tips and links to applicable rebate programs.
- Irrigation System Evaluations and Rebates – Free Irrigation System Evaluations by a licensed irrigator from Austin Water for customers with in-ground sprinkler systems that have used either more than 25,000 gallons in one month or more than 20,000 gallons in two consecutive months. Customers can also receive rebates of up to $400 for improving the water efficiency of their irrigation system.
- Landscape Survival Tools Rebate - Residents can receive up to $180 for mulch, compost and yard aeration to help retain soil moisture and more efficiently water their lawns.
- Low Income Water Efficiency Assistance – Austin Water partners with Austin Energy to provide free high efficiency aerators and showerheads to low income customers through AE's Weatherization Assistance Program. AW is currently developing its own direct assistance plumbing repair program for low-income single-family customers as well as a new grant program for water lateral repair for low income single family customers similar to the current program for wastewater laterals.
- Pool Cover Rebate – Residents can receive a rebate for half of the purchase price up to $50 for a new manual pool cover or solar rings, or $200 for a new permanent, mechanical pool cover.
- Pressure Regulating Valve Rebate – Residents can receive a rebate of up to $100 for the purchase and installation of a Pressure Regulating Valve.
- Rainwater Harvesting Rebate – Residential, multi-family, and commercial customers or qualifying water providers can receive up to $5,000 for purchasing equipment to capture rainwater.
- Watering Timer Rebate – Residents can receive a rebate of $40 or 50% of the cost of purchasing up to two hose timers.
- WaterWise Landscape Rebate – Residential customers may receive $35 for every 100 square feet (minimum 500 square feet) of converted landscape with a maximum rebate of $1,750.
- WaterWise Rainscape Rebate – Schools and homeowners can receive up to $500 for installing landscape features that direct and retain rainwater/runoff, such as berms, terraces, swales, rain gardens, porous pavement, and infiltration trenches.

6.3.6 Incentive Programs for Homeowner Associations and Multi-Family Facilities

Austin Water offers the following incentive programs for homeowner associations and multi-family facilities:

- Multi-Family Efficiency Program – Austin Water partners with Austin Energy to provide free high efficiency aerators and showerheads to multi-family facilities with low income tenants through AE's Multifamily Efficiency Program.
- Pressure Reduction Valve Rebate – Multi-family Facilities can receive a rebate of up to $500 for the purchase and installation of Pressure Reduction Valves.
- Rainwater Harvesting System Rebate - Multi-family facilities can receive up to $5,000 for purchasing equipment to capture and use rainwater.
- Waterwise Landscape Rebate – homeowner associations may receive $35 for every 100 square feet (minimum 500 square feet) of converted landscape with a maximum rebate of $1,750.

6.3.7 Incentive Programs for Businesses

Austin Water offers a variety of water conservation incentive programs for businesses.

- 3C Business Challenge - A "desk top" water efficiency auditing tool that allows businesses the opportunity to show their commitment to saving water and gain information about ways to reduce water usage. The challenge also provides tools and information to help them incorporate sustainable practices and links to related rebate programs.
- "Bucks for Business" Commercial Rebate - This program offers rebates for equipment and process upgrades that save water and exceed city water efficiency requirements of up to $100,000. Rebates offered under this program include but are not limited to: air conditioner (AC) condensate recovery, ozone treatment systems for large commercial laundry facilities, cooling tower efficiency upgrades, process water reuse and recycling systems.
- Commercial Kitchen Rebate – This program offers up to $2,500 for Environmental Protection Agency WaterSense/Energy Star labeled commercial kitchen equipment.
- Green Building Program – AW participates in Austin Energy's Green Building (AEGB) Program by providing information on water efficiency related code requirements, potential water use efficiency best management practices, alternative water recommendations, water use benchmarking data, and information on available incentive and rebate programs that can be used to achieve the desired or required rating. Certain City of Austin ordinances and programs (for example, the S.M.A.R.T. Housing Program) mandate that a particular AEGB star rating be achieved. In addition, an AEGB rating can be required through zoning ordinances of projects located in defined areas of the city such as high density/growth areas.
- Industrial, Commercial and Institutional Audit Rebate – Industrial, commercial and institutional customers may receive up to $5,000 for an independent audit of their facility to identify potential water and cost savings.
- Irrigation System Improvement Rebates, Austin Water offers a rebate of up to $5,000 for a central computer irrigation controller system. Additional rebates are available under this program for flow sensors, multi-stream nozzles, and master valves.

- Property Assessed Clean Energy (PACE) - Austin Water assists the Travis County Property Assessed Clean Energy loan program in identifying eligible water conservation opportunities and retrofits that also qualify for an Austin Water rebate.
- Rainwater Harvesting System Rebate – Industrial, commercial and constitutional customers may receive up to $5,000 for purchasing equipment to capture and use rainwater.
- Reclaimed Water – Austin Water is expending its distribution system to provide less expensive municipal treated wastewater rather than potable water to meet non-potable water needs such as irrigation and cooling towers.
- Small Business – AW partners with Austin Energy's Small Business Program that helps identify ways for small commercial and non-profit customers to reduce water and energy use and related rebate programs.
- WaterWise Hotel Partnership Program - Offers free recognition for lodging facilities that use water-efficient measures and practices.

6.3.8 Water Loss Control

One of the primary conservation goals of Austin Water's utility is to manage water loss due to leaks in their distribution system. Austin Water launched "Renewing Austin" which invests $125 million in a five-year program to replace aging water lines. Austin Water has experienced a record number of water leaks because of extreme drought conditions. Austin Water has inspected more than 1,500 miles of water lines for leaks using acoustic technology. A five-year program of inspecting the entire distribution system has been completed and the information gained from these inspections is now being used to enhance Austin Water's active leak detection program. Austin Water has also initiated an accelerated leak response and repair program that has proven highly successful, with most leaks now repaired in one day or less and almost 90% of emergency leaks responded to within three hours.

A common performance indicator for real water losses from a supply network is the Infrastructure Leakage Index. The Texas Water Development Board recommends an Infrastructure Leakage Index between 3.0 and 5.0. Austin Water currently maintains a goal to achieve an Infrastructure Leakage Index of 3.0 or less (lower scores are better) and often exceeds this goal through its accelerated leak response and repair program.

6.3.9 Advanced Metering Infrastructure Pilot Program

Recently, Austin Water has been investigating and studying the cost and feasibility of implementing Advanced Metering Infrastructure (AMI) and has implemented a pilot program, which involves installing 'smart' meters in a small portion of the city which can automatically report daily, hourly, or more frequent water usage to the utility and the customer. AMI can identify customers with the largest potential to conserve water by evaluating advanced analytics to provide precise water conservation targets. These calculations provide individual water conservation recommendations directly to customers based on climate, parcel size, vegetation coverage and other information derived from aerial imaging surveys. Austin Water has procured a consultant to assist in scoping the replacement of all retail customer meters with smart meters. Additionally, Austin Water has applied for low-interest loan funding for AMI through the State Water Implementation Fund for Texas.

6.3.10 Water Conservation Public Education Programs

Austin Water has several public educational programs to promote the City's conservation incentive programs and water efficiency measures, as well as increase customer awareness of water usage and leaks. The following list provides a summary of the water conservation educational programs.

- WaterWise Partner Program - a program that recognizes commercial customers that have incorporated efficiency measures into the design of new properties or that have made comprehensive water-efficiency upgrades in the facilities.
- Dowser Dan Show – Targeting kindergarten through fourth grade students, the Dowser Dan show educates children and teachers about water conservation and reaches approximately 18,000 students each year.
- Mobile Classroom – The mobile exhibit is housed inside a 40-foot trailer and utilizes interactive exhibits and hands-on activities, functioning as a mobile science museum.
- Speakers Bureau – Allows area groups to schedule Austin Water staff members to speak on topics including, but not limited to, conservation measures, irrigation, leak detection, and water waste.
- WaterWise Irrigation Professional Seminar – Seminars that include information on water-efficient irrigation systems, water conservation programs, the mandatory watering schedule, electrical troubleshooting, irrigation auditing, and turf grass watering requirements so that licensed professional irrigators in the area can earn credits toward their license renewal.
- Annual Austin Water/LCRA Industrial, Commercial and Institutional Water Conservation Technical Workshop – An annual free water conservation technical workshop on water saving measures, technologies, and rebate programs for industrial, commercial and institutional customers, facility managers and engineers.
- "Controller 101" Workshops – Residential customers may attend a free hands-on workshop to review how irrigation controllers work and find out about hidden features and options that can help save water and money.
- Irrigation System Maintenance for Efficiency – Free workshops to teach basic maintenance skills to maximize performance and efficiency of irrigation systems to manage landscapes and to reduce watering costs.
- Online Information, Electronic Newsletters and Social Networking – Covers conservation related topics via www.WaterWiseAustin.org, Facebook, Twitter, NextDoor, YouTube, and an e-Newsletter that reaches approximately 30,000 customers.

6.4 Candidate Future Water Conservation and Demand Management Strategies Considered

In support of the IWRP, candidate future water conservation and demand management strategies were identified to evaluate their potential to help the city meet their long-term water supply needs. Demand management measures were identified based on input from the Water Forward Task Force members, Austin Water staff, the public, the consulting team, previous task force recommendations, and the Water Conservation Study[9] conducted through the Office of Sustainability.

From a “blue sky” list of 65 options, an initial list of 25 options was developed. Of the initial 25 options, two were re-categorized as supply side options, two were determined to be continuing best management practices, and three were determined to be necessary implementation components to other options. The remaining options were combined or split out into one or more options, thereby reducing the number of options for screening to thirteen. An overview of the demand management screening process is included in **Appendix H**.

Through the options screening process, a list of 10 options were identified to be carried forward to the option characterization process. During the characterization process, the list of ten was further refined into a list of 12 with each of several alternative water options being listed separately. (See **Section 3:** for discussion on the screening process). A summary of the 12 resulting options, which were carried forward and used in the portfolio development and evaluation process, is provided in **Table 6-2.**

[9] Water Conservation Study, September 30, 2015, prepared by Maddaus Water Management, Inc, for City of Austin, Office of Sustainability, and Austin Water Utility. Posted in Austin Integrated Water Resource Planning Community Task Force regular meeting materials from October 6, 2015: http://www.austintexas.gov/edims/document.cfm?id=240290

Table 6-2. Candidate Future Water Conservation and Demand Management Strategies Considered

Option Number	Option Name		Annual Community Unit Cost Per AF of Savings
D1	Advanced Metering Infrastructure		$2,800
D2	Water Loss Control Utility Side		$3,690
D3	Commercial, Industrial, and Institutional Ordinances (Cooling Towers and Steam Boilers)		$71
D4	Water Use Benchmarking and Budgeting		$21
D5	Landscape Transformation Ordinance		$23
D6	Landscape Transformation Incentives		$96
D7	Irrigation Efficiency Incentives		$202
D8	Alternative Water Ordinances and Incentives	Lot Scale Stormwater Harvesting	$5,510 - $5,062
D9		Lot Scale Rainwater Harvesting	$2,619 - $2,960
D10		Lot Scale Graywater Harvesting	$3,898 - $10,666
D11		Building Scale Wastewater Reuse	$12,692
D12		Air Conditioning Condensate Reuse	$2,702

The following sections provide a short description of the candidate options. A more comprehensive summary for each option providing the conceptualized yield, the overall community cost, and assumptions made in developing each of the final demand management options can be found on the options characterization sheets in **Appendix J**. For information on candidate demand management options that were chosen as recommended strategies, see **Section 9-1**.

6.4.1 Advanced Metering Infrastructure (AMI)

Advanced Metering Infrastructure (AMI), also known as smart meters, record near real-time water use and provides that information to customers through an easy-to-use interface such as a web or a smart phone application. The AMI option targets all customers and sectors. Savings are primarily achieved through identification of customer leaks, behavior modification, and other water-saving opportunities that are realized because of: (1) improving customer meter accuracy, (2) reducing unauthorized consumption, (3) reducing data transfer/archive errors, and (4) reducing data billing errors.

6.4.2 Utility-Side Water Loss Control

This option represents an expansion of Austin's existing water loss program to reduce leaks in the water distribution system. While the target Infrastructure Leakage Index (ILI) for Austin Water is sustaining an ILI at or below 2.7, from fiscal year 2013 to 2015 Austin Water lost an amount of water which equates to an infrastructure leakage index of 3.26. The Water Forward recommendation includes an aggressive leak detection, correction, and prevention program to reduce the ILI to 2.7 by 2020 and further reduce and sustain a 2.0 ILI from 2040 to 2115. The savings analysis for this option focused on four pillars of real water loss control: (1) active leak detection, (2) improving response time to leaks, (3) pressure management, and (4) pipeline and asset management selection, installation, maintenance, renewal, and replacement. This option represents savings from reductions in real losses and has potential synergies with strategies like Advanced Metering Infrastructure (AMI) which may also target apparent losses. Real losses are almost entirely comprised of leaks in the distribution system whereas apparent losses are almost entirely comprised of meter inaccuracies. This option targeted both new and existing development in all sectors.

6.4.3 Commercial, Industrial, and Institutional (CII) Ordinances

There are over 400 cooling towers in Austin which are designed to remove heat from a building or facility for the purposes of heating, ventilation, and air conditioning. In the process of cooling air, some water is evaporated, and the rest is recycled through the cooling tower. The greater the number of cycles that the water is recycled through, also known as cycles of concentration, the more efficient the cooling tower becomes.

This ordinance requires: (1) all existing and new cooling towers to meet same efficiency equipment standards required for new and replacement towers since 2008 (makeup and blowdown submeters, conductivity controller, drift eliminator and overflow alarm) and achieve 5 cycles of concentration; and (2) all steam boilers in new development to have conductivity controllers, makeup meters, steam condensate return systems and blowdown heat exchangers for steam boilers. These code changes have already been approved by City Council in June 2017 and implementation is underway. This ordinance targets existing development HVAC uses in the multi-family residential, commercial, and City of Austin sectors.

6.4.4 Water Use Benchmarking and Budgeting

Water use benchmarking and budgeting uses standards to "benchmark" how much water buildings of a certain size and type would be expected to use. Based on these benchmarks, a "water budget" can be created to track water use in a given building and help users meet their water benchmark. This option would be implemented in two phases.

Phase I

- Potential approaches to implement this requirement for pre-and post-development of multi-family and commercial facilities will be evaluated and include public outreach, review by Boards and Commissions and Council action.
- As part of this program:
  - Developers will provide information about all water-using equipment and fixtures associated with the site (including counts), proposed water sources, irrigated area, landscaped area, and other water-use, site, and building characteristics.
  - City staff will provide water efficiency related code requirements, potential water use efficiency best management practices, alternative water recommendations, water use benchmarking data, and information on available incentive and rebate programs for new and existing development. Implementation of the measure will look for ways to tie into the Service Extension Request, Austin Energy's Green Building program, the city's Energy Conservation Audit and Disclosure program, and AMI customer portals for multi-family and commercial use.

Phase II

- Based on the water use benchmarking data developed through these programs, this strategy will be expanded in the future to include a water use budget for new development constructed after 2025 (compliance mechanism to be determined).

6.4.5 Landscape Transformation Ordinances

Landscape transformation is a process of transitioning from traditional landscaping practices to those that rely on regionally appropriate plants and have reduced supplemental water needs, with an emphasis on landscape function. Note that the current Landscape Ordinance has existing requirements for landscaped areas, plant selection, and irrigation systems for Commercial and Multifamily properties. This option would include development of a new ordinance to require water efficient landscapes be installed with new single-family residential development, thus savings from this option would primarily come from the single-family residential sector. Implementation of this option could include implementing turf grass area, irrigated area, and/or irrigation area limitations. If implemented, more detailed ordinance concepts and language will be developed through subsequent implementation processes with future additional public input opportunities.

6.4.6 Landscape Transformation Incentives

This option focuses on incentives for existing development to encourage reductions in water needs for outdoor irrigation through regionally appropriate landscapes with an emphasis on landscape functionality. The current WaterWise landscape rebate offers $35 for every 100 square feet ($0.35/square feet) converted, with a maximum rebate of $1,750 per property. The current program has traditionally had a low participation rate. Implementation of this option could include increasing WaterWise landscape rebates for single-family residential and multi-family residential and implementing a new WaterWise landscape rebate for commercial beyond City of Austin Land Development Code requirements.

6.4.7 Irrigation Efficiency Incentives

Outdoor water use comprises over 22% of the water currently used by Austin Water customers with most of that water used for landscape watering. Over 89,000 homes and over 5,000 businesses have irrigation and sprinkler systems, which often are programmed to turn on at certain times of the day without regard to weather or plant water needs. This option focuses on expanding existing Austin Water rebate programs to incentivize “smart” irrigation controllers that would improve irrigation system efficiency by responding to leaks, high pressure, and soil moisture and also make flow data accessible.

6.4.8 Alternative Water Ordinance and Incentives

This option would require or incentivize on-site (building-scale) alternative water use of rainwater, stormwater, graywater, blackwater, and/or air conditioning condensate through a mix of ordinances and incentive programs. While these alternative water sources can already be used on-site and related codes and ordinances already exist, this “Alternative Water Ordinance and Incentives” option in Water Forward targets new ordinances and incentives aimed at use of these alternative water supplies. Information for Austin Water customers who are considering collecting rainwater, graywater, stormwater, air conditioning condensate or other non-sewage originated waters on their property (onsite), and reusing them for non-potable applications is available on Austin Water’s On-Site Water Use Systems[10] web-page.

This Water Forward option would require development of new ordinances to require or programs to incentivize implementation of these projects. If implemented, more detailed incentive program and ordinance concepts and language will be developed through subsequent implementation processes with future additional public input opportunities. Further information for each of the lot-scale options is provided

[10] http://www.austintexas.gov/page/onsite-water-reuse-systems

in the following sections. More detail on the decentralized options is provided in the characterization sheets in **Appendix J** and **Appendix K.**

6.4.8.1 Lot Scale Stormwater Harvesting

Lot scale stormwater harvesting involves the capture and storage of stormwater runoff generated from impervious surfaces (including roof water) within the lot boundary of multi-family residential or commercial development. The collected stormwater is then used to supply a range of onsite demands. Implementing stormwater harvesting in new developments provides an opportunity to plumb the building with internal connections for toilet flushing, clothes washing or to cooling towers. Retrofitting existing buildings with internal connections to a dual supply source can be cost prohibitive and practically difficult. It is assumed for the purposes of this plan that stormwater harvesting at the lot scale for existing development would be used solely for irrigation/landscaping. Where used for irrigation/landscaping only, it is assumed that there will be filtration. Where used to supply indoor non-potable end-uses, it is assumed UV disinfection is also required. Storage is assumed to be an underground tank/cistern.

Two scenarios were considered for establishing typical yields and costs for this option:

- A proportion of newly constructed multi-family and commercial buildings have an underground stormwater harvesting tank supplying outdoor end uses.
- A proportion of newly constructed multi-family and commercial buildings have an underground stormwater harvesting tank supplying outdoor end uses and indoor (non-potable) end uses via dual pipe network.

6.4.8.2 Lot Scale Rainwater Harvesting

Rainwater in urban areas is often routed to a storm drain pipe network and discharged to streams and flood control channels that lead to the ocean. Typically, this runoff carries with it pollutants and trash that have been picked up along parking lots, streets, and other impervious surfaces. Rainwater harvesting (lot scale) involves the capture and storage of roof water to supply a range of onsite demands at the lot/building scale.

Three scenarios were considered for establishing typical yields and costs for this option. The options include:

- A proportion of newly constructed single family, multi-family and commercial buildings have a rainwater tank supplying outdoor end uses.
- A proportion of newly constructed single family, multi-family and commercial buildings have a rainwater tank supplying outdoor end uses and indoor (non-potable) end uses via dual pipe network.
- A proportion of newly constructed single-family buildings have a rainwater tank supplying all end uses (i.e. potable supply).

6.4.8.3 Lot Scale Graywater Harvesting

Graywater harvesting is defined as the reuse of water from the laundry, shower and bath at the lot/unit scale to meet non-potable demands. There are two main types, greywater diversion devices and greywater treatment systems. Graywater diversion is untreated, and therefore cannot be stored and can only be used to supply sub-surface irrigation. They typically include a surge-tank and may include a filter. The system may be gravity fed or require a pump, depending on the site. Graywater treatment systems include treatment, storage and a pump. The treated graywater can be reused to supply outdoor end use demands as well as non-potable indoor end use demands (toilet flushing and clothes washing).

Two scenarios were considered for establishing typical yields and costs for this option (proportion referring to a portion of the project opportunities/systems identified in the analysis). The options include:

- A proportion of newly constructed single family, multi-family and commercial buildings have a graywater diversion system supplying outdoor end uses.
- A proportion of newly constructed single family, multi-family and commercial buildings have a graywater treatment system supplying outdoor and indoor end uses.
- Both scenarios assume back-up supply from the centralized water distribution system.

6.4.8.4 Lot/Building Scale Wastewater Reuse

Building Scale Wastewater Re-use (or ‘Blackwater Treatment Plants’) is defined, for the purpose of this project, as involving the onsite capture and treatment of the wastewater stream generated from a building for onsite reuse via a dual (purple) pipe system to supply outdoor demands (irrigation/landscaping) and non-potable indoor demands (toilets and potentially also laundry and cooling towers). Blackwater treatment plants are most commonly installed in commercial buildings and high density, multi-story multi-family residential buildings. Treatment may be one or a combination of membrane bioreactor, moving bed biofilm reactor, passive (e.g. engineered wetlands) or other systems, with microfiltration or ultrafiltration, and ultraviolet disinfection and/or chlorination. Wastes (sludge) from the treatment process are typically discharged back to the wastewater network.

A single scenario was considered for establishing typical yields and costs for this option. The scenario considers that a proportion of newly constructed multi-family and commercial buildings have a blackwater treatment system supplying outdoor and non-potable indoor end uses (proportion referring to a portion of the project opportunities/systems identified in the analysis). Two critical assumptions are made for blackwater systems:

- Blackwater reuse is not considered for outdoor end uses in Critical Water Quality Zones, floodplains, or the Edwards Aquifer Recharge Zone.
- All scenarios assume back-up supply from the centralized water distribution system.

6.4.9 Air Conditioning Condensate Reuse Ordinance

This option, which is already in code, is focused on the collection of air conditioning (AC) condensate water from air handling units (AHUs) from new development with a cooling capacity over 200 tons. The condensate water could be reused for beneficial use for any non-potable application including (but not limited to): cooling tower makeup water, irrigation, and indoor toilet flushing. AW will continue to monitor the success of this ordinance.

6.4.10 Other Options Re-categorized in the Planning Process

Of the initial demand management options, there were several that were identified as continuing best management practices rather than new options, and three were identified as necessary implementation components to other options. These include the following:

- The option to require or incentivize government-recognized energy and water efficiency-labeled residential and commercial fixtures was determined to be a "*continued best management practice*" to be included in demand offsets separately (i.e., off-the-top reduction from the baseline forecast that does not require evaluation through the IWRP process) and reflects Austin Water's longstanding programs to incentivize or require these fixtures. Water saving estimates from this best management practice option and passive water conservation from water efficient fixtures are shown in Table 6-3 and are incorporated into the Water Forward baseline demand projection.

Table 6-3. Water Savings Estimates from Passive Conservation and Best Management Practices

2020	2040	2070	2115
0	4,033 AFY	15,699 AFY	54,355 AFY

- Three options were determined to be "*implementation components*" of a successful conservation program and were not further evaluated or screened. These measures include water rates and fees to promote water use efficiency while maintaining affordability, customer education enhancements, and use of social media programs and web-based content to promote conservation. While these types of programs are indeed critical to a successful conservation program, they may not necessarily have significant water savings of their own, but rather assure the successful implementation of other programs.

The options described in this subsection are considered options that are being implemented as part of Austin Water's ongoing commitment to implement demand management and conservation measures.

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SECTION 7: WATER SUPPLY STRATEGIES

The Colorado River is Austin's core water supply through a combination of state-granted water rights and firm water supply contracts with LCRA. The Colorado River has a series of reservoirs, known as the Highland Lakes, that are used by LCRA to store water for municipal, industrial, recreation, and agricultural water needs as well as to meet in-stream flow requirements throughout the river down to Matagorda Bay on the Texas gulf coast. The following section describes the current water supply infrastructure associated with Austin's existing Colorado River water supply. The section also describes the candidate future water supply options evaluated and considered as part of the planning process. For information on which candidate supply options were chosen as recommended strategies, see **Section 9-1**.

AT A GLANCE

- *Current Water Supply System*
- *Candidate Future Water Supply Options Considered*

7.1 Current Water Supply System

The following sections describe Austin Water's current surface water and reclaimed water systems. It should be noted that additional future water and wastewater plant expansions along with major collection and distribution system improvements will also be required to provide water and wastewater services through the 100-year planning horizon.

7.1.1 Surface Water System

Utility customers are supplied with drinking water from three surface water treatment plants, which draw water from the Colorado River as the river runs through Lake Travis and Lake Austin. The City's combined water treatment capacity is currently 335 MGD.

As described in **Section 2.2**, Austin's main sources of water supply are its own run-of-river water rights, backed up by a firm water supply contract with the LCRA. In 1999, Austin entered into a long-term firm water supply agreement with LCRA for 325,000 AFY. Austin paid $100 million in prepaid reservation and use fees for 325,000 AFY of firm water supply. Austin's annual municipal diversions were approximately 149,000 AFY in 2017. Additional water payments by Austin to LCRA will be triggered when average annual water diversions for two consecutive years exceeds 201,000 AFY. The current contract runs through the year 2050 with an option for Austin to extend the agreement to 2100. The IWRP assumes that the City will extend its current LCRA contract to 2100 and be able to enter into an agreement with LCRA to renew it at that time.

7.1.2 Reclaimed Water System

Wastewater is treated at two major wastewater treatment plants with a combined capacity of 150 MGD and various small-scale treatment plants. Austin Water operates and manages an expanding reclaimed water system which provides reclaimed water to customers for a variety of non-potable uses. The system currently has approximately 59.3 miles of reclaimed water pipe covering three different service areas and supplies approximately 4,000 AFY of water to 120 metered customers annually. Bulk reclaimed water is also available to customers at three bulk fill stations[11].

7.2 Candidate Future Water Supply Options Considered

In support of the IWRP, future water supply options were identified and evaluated to determine their potential to help the City meet identified water supply goals. A total of 21 water supply options were identified through a collaborative process, involving Austin Water staff, the current Task Force, the 2014 Austin Water Resource Planning Task Force report, and the public. These options were then screened as described in **Section 3**: and **Appendix I** to identify a total of 13 supply options for further characterization and use within the portfolio development process. These 13 water supply options are summarized in **Table 7-1.** and discussed in more detail in the following section.

Table 7-1. Candidate Future Water Supply Options Considered

Option Number	Option Name	Option Type	Annual Unit Cost ($/AF)
S1	Aquifer Storage and Recovery	Storage / Surface Water	$1,053
S2	Brackish Groundwater Desalination	Desalination / Groundwater	$2,690
S3	Direct Non-Potable Reuse (Centralized Reclaimed Water System) - Master Plan	Reclaimed Water	$1,229
S3-A	Direct Non-Potable Reuse (Centralized Reclaimed Water System) - Expanded System beyond Master Plan	Reclaimed Water	$6,127
S4	Direct Potable Reuse	Reclaimed Water	$2,204
S5	Indirect Potable Reuse (IPR) through Lady Bird Lake and Capture Local Inflows to Lady Bird Lake	Reclaimed Water and Local Inflows	$605
S6	LCRA Additional Supply	Surface Water	$352
S7	Off Channel Reservoir	Storage / Surface Water	$846
S8	Seawater Desalination	Desalination	$3,032
S9	Distributed Wastewater Reuse	Reclaimed water / Decentralized System	$9,612
S10	Sewer Mining	Reclaimed water / Decentralized System	$3,030 - $6,444
S11	Community Scale Stormwater Harvesting	Decentralized	$1,522 - $3,233
S12	Community Scale Rainwater Harvesting	Decentralized	$9,612
S13	Conventional Groundwater Operated by Austin Water	Groundwater	$1,119

The following section provides a brief summary for each of the candidate options. A comprehensive summary for each option providing the projected yield, cost, and assumptions made in developing each of

[11] http://www.austintexas.gov/sites/default/files/files/Water/Water_Reclamation/locationsbulkfill.pdf

the final water supply options can be found in **Appendix J**. For information on candidate supply options that were chosen as recommended strategies, see **Section 9-1.**

7.2.1 Aquifer Storage and Recovery

Aquifer storage and recovery (ASR) is a strategy in which water can be stored in an aquifer during wetter periods and recovered at a later date. Storing water underground can improve drought preparedness in the same way storing water in a reservoir does, while eliminating the water loss due to evaporation that occurs in open above-ground reservoirs. Although some losses may occur using ASR through leakage or migration, the losses are much smaller than surface evaporation on an above-ground reservoir of similar size. ASR is currently being used by cities in Texas, such as San Antonio, Kerrville and El Paso. Exploring ASR as a potential water storage option was a recommendation of the 2014 Task Force.

Austin had previously initiated feasibility analyses to better understand the geology and hydrogeology characteristics of the Northern Edwards and Trinity Aquifers to evaluate potential for recharge and extraction. These analyses found that regulatory restrictions would prevent injecting into or transecting the Edwards Aquifer, making it very difficult to proceed with ASR concepts in the Edwards or Trinity Aquifers in Travis County. Also, The Carrizo Wilcox Aquifer has more favorable geologic properties for storage of water that would increase the amount of water that is able to be recovered from the aquifer. However, in Water Forward the Aquifer Storage and Recovery concept that was evaluated was located in the Carrizo Wilcox Aquifer. This option includes facilities to pipe treated drinking water from Austin's distribution system to an ASR wellfield for injection and storage in the Carrizo-Wilcox aquifer. Facilities also include a pump station and storage tank to convey recovered water from the ASR wellfield to the city’s distribution system.

Aquifer Storage and Recovery facilities would be planned to serve solely a storage function, allowing for maximization of surface water resources during drought periods. This concept is in keeping with the Water Forward guiding principle of maximizing locally available water resources. Site selection will depend on favorable hydrogeology to fulfill the ASR facility’s intended storage purpose. In implementing this option, Austin Water would work to develop and test a pilot facility to assess potential site characteristics and ensure that the strategy’s objective to store surface water in and recover surface from the aquifer is achievable. The ASR option is in no way intended to be a strategy to develop native groundwater. To be clear, the ASR injection and recovery wells are in no way intended to pump native groundwater from the Carrizo Wilcox Aquifer and convey that water to Austin via a transmission pipeline. Potential implementation issues for ASR include understanding the potential migration of stored water and mixing with the native groundwater, protection of stored surface water from recovery by others, and navigating changing regulatory requirements for ASR.

7.2.2 Brackish Groundwater Desalination

Brackish groundwater is defined as groundwater containing between 1,000 and 10,000 milligrams per liter (mg/L) of total dissolved solids. Desalination is often required to remove dissolved solids from brackish groundwater, or brackish water can be blended with another low-total dissolved solids source water to reduce total dissolved solids levels. The specific process used to desalinate water varies depending upon the total dissolved solids, the temperature, and other physical characteristics of the source water, but always requires disposal of concentrate, called brine, that has a higher total dissolved solids content than the source water. The City of El Paso has been treating 27.5 MGD of brackish groundwater since 2007, while the San Antonio Water System started up a 12 MGD brackish groundwater desalination project in 2016. Exploration of brackish groundwater desalination for the Water Forward process was a recommendation of the 2014 Task Force.

There are several aquifers within Central Texas which could be considered for brackish groundwater, including the Edwards, Trinity, Gulf Coast, and Wilcox Aquifers. Facilities associated with this option include the wellfield, pump station, storage tank, and reverse osmosis treatment facilities. Evaporation ponds were assumed to be used for brine disposal. Potential implementation issues for brackish groundwater desalination include concentrate disposal and blending with current supply sources.

7.2.3 Direct Non-Potable Reuse (Centralized Reclaimed Water System)

Direct non-potable reuse water is also known as recycled water, reuse water, or reclaimed water. This is water that has been treated to Type 1 standards as defined by the Texas Commission on Environmental Quality for non-drinking water uses such as irrigation, cooling, manufacturing, and toilet flushing. As described in **Section 7-17.1.2**, Austin Water has a Water Reclamation Initiative underway, which currently supplies approximately 4,600 AF per year. The direct non-potable reuse option considered as part of the IWRP would expand this program to provide additional non-potable water supply through the centralized reclaimed water network. This expansion was conceptualized to occur in two phases over the 100-year planning horizon.

The first phase would include implementation of the current Reclaimed Water Infrastructure Master Plan (2011) and the program described in the 2016 Lower Colorado Regional Water Plan. Facilities included in this phase consist of a total of nine reclaimed pump stations, ten storage facilities and approximately 110 miles of reclaimed pipeline transmission main. Potential additional facilities may also be required to meet 2040 yield targets.

The second phase would focus on direct non-potable use in anticipated growth areas based on demand model estimates between 2070 and 2115. As part of this high-level analysis, facilities included in this phase would include a total of seven reclaimed pump stations, six storage facilities and approximately 66 miles of reclaimed pipeline transmission main. Future modeling and analysis would be required to develop detailed infrastructure requirements as part of this option. Additional cost was included to reflect community costs associated with dual-plumbing which is required for indoor non-potable water use. Potential implementation issues for non-potable reuse include the need for voluntary customer participation to increase utilization, challenges with public opinion, and the need for public education on water safety.

7.2.4 Direct Potable Reuse

Direct potable reuse represents a relatively new approach to maximizing available water resources that involves advanced treatment of wastewater effluent for the purposes of meeting drinking water needs. Although new, several communities in Texas have implemented direct potable reuse projects to address their water supply needs. A full-scale project was implemented by the Colorado River Municipal Water District for the City of Big Springs in 2013 (2 MGD) and the City of Wichita Falls implemented a temporary project in 2012 (10 MGD) as a drought response strategy.

The option evaluated for this study would directly convey highly treated reclaimed water through a pipe from one treatment train at South Austin Regional WWTP to the Ullrich WTP. The effluent would be treated on-site at Ullrich WTP using a new advanced water treatment train, potentially including microfiltration and reverse osmosis. The treated water would then be blended with raw water prior to being pumped back to the headworks of Ullrich WTP for treatment through the conventional water treatment process to produce potable drinking water. Although direct potable reuse offers benefits such as a climate resilient supply, it presents significant regulatory uncertainty, which can impact when and if direct potable reuse projects can be implemented. Potential implementation issues for direct potable reuse include regulatory uncertainty challenges with public opinion, and the need for public education on water safety.

7.2.5 Indirect Potable Reuse with Capture Local Inflows to Lady Bird Lake

7.2.5.1 Indirect Potable Reuse (IPR) through Lady Bird Lake

Indirect potable reuse (IPR) was evaluated in Water Forward as an emergency strategy to be used infrequently during only the most severe drought situations. During deep drought periods, when combined storage of the Highland Lakes is lower than at any point in the historical period of record, IPR would be an emergency supply to meet potable water demands. The term "indirect" in the name of this option means that rather than conveying highly treated reclaimed water directly to a water treatment plant, reclaimed water is conveyed indirectly through a natural buffer like a stream to the point of final treatment to potable drinking water quality. The City of Wichita Falls recently implemented an IPR project in response to drought which sends up to 16 million gallons per day (MGD) of wastewater to Lake Arrowhead, which provides a buffer prior to treatment at the surface water treatment plant.

The representative option evaluated for this plan would convey highly treated reclaimed water from one treatment train at South Austin Regional WWTP to Lady Bird Lake through a reclaimed water transmission main and subsequently divert this water through a new intake pump and piping system downstream of Tom Miller Dam to be conveyed to Ullrich WTP. This concept could utilize a reclaimed main from South Austin Regional WWTP to Lady Bird Lake that is already included in the Reclaimed System Master Plan. This approach would supplement water releases from Lakes Buchanan and Travis to extend water supplies during severe drought only. This option is a drought strategy that would be recommended for implementation only in the event of 400,000 AF of combined storage or less in Lakes Buchanan and Travis, which is after the lakes have dropped below emergency and crisis levels. This option would be utilized for the shortest possible time to meet urgent supply needs. Should this option be required to be utilized in a deep drought emergency, Austin Water would perform outreach to educate and notify the public about the use of the strategy, develop robust standards to guide operations for the period when the strategy is in use, perform monitoring to ensure drinking water quality standards are met, and monitor water quality in Lady Bird Lake. Potential implementation issues for indirect potable reuse include challenging permitting process, challenges with public opinion, and the need for public education on water safety.

7.2.5.2 Capture Local Inflows to Lady Bird Lake (infrastructure also included as part of IPR, above)

As the IPR option would only be used on an infrequent basis during severe drought conditions, the intake and pumping components could be used on a more frequent basis to capture spring flows to Lady Bird Lake when available. Lady Bird Lake inflows would be conveyed to Ullrich WTP for treatment and distribution. The average annual yield for the Capture Local Inflows to Lady Bird Lake strategy is estimated to be approximately 3,000 AFY. Water availability for the Capture Local Inflow to Lady Bird Lake option would be intermittent and seasonal, with availability more likely in the months of November through February when downstream agricultural irrigation operations are offline and environmental flow requirements are the lowest for the year. Potential implementation issues for Capture Local Inflows include that water availability would be intermittent and seasonal.

7.2.6 Additional Supply from Lower Colorado River Authority (LCRA)

Water from the Colorado River through its water rights and firm contract with LCRA is the primary source of all raw water for Austin; this water is treated and used to meet Austin's demands. This option would involve securing additional supply from the LCRA through a new or amended contract. Currently LCRA has approximately 54,600 acre-feet of water available for contracting (50,000 acre-feet of which is the LCRA Board of Director's reserve amount and is subject to contracting approval by the LCRA Board of Directors). The additional LCRA supply would be accessed using existing and future treatment and transmission infrastructure. There could be additional supply available for contracting over time as LCRA plans to continue to develop additional supplies in the future. Potential implementation issues for contracting more LCRA supply include uncertainties regarding future availability of water.

7.2.7 Off-Channel Storage Reservoir

This strategy would involve the construction of a new off-channel reservoir in the Austin region that Austin Water would own and operate. An off-channel reservoir is constructed away from the main stem river channel and is filled by pumping water in from the main river channel to the reservoir. This type of reservoir requires additional infrastructure, such as impoundment structures and pump stations to move water from the main river channel.

The off-channel reservoir option being considered would likely use source water from the Colorado River during times when water is available. The approximate size of this reservoir would be up to 25,000 AF. An evaporation suppressant could be applied during summer months to reduce water lost through evaporation. The off-channel reservoir could also be used conjunctively with ASR, allowing further storage and evaporation management opportunities. Potential implementation issues for an off-channel storage reservoir include significant land area requirements and that the yield of the reservoir is dependent on the reliability of the source water.

7.2.8 Seawater Desalination

Desalination is the process of removing dissolved solids from seawater or brackish groundwater, often by forcing the source water through membranes under high pressure. The desalination process generates waste product known as brine that has a higher total dissolved solids content than the source water. Disposal of the brine may take the form of an injection well, evaporation beds, or an ocean outfall diffuser. This option would involve sourcing water from the Gulf of Mexico and treating it via a desalination plant where dissolved solids are removed by forcing the source water through membranes at high pressure. This option could be implemented through a regional partnership approach. Potential implementation issues for seawater desalination include challenging permitting and regulatory issues and a high per-unit cost due to the energy intensity.

7.2.9 Community Scale Distributed Wastewater Reuse

Distributed Wastewater Reuse is the collection of effluent from the wastewater system in localized new development areas (completely separate from the centralized wastewater collection system), treatment to Type 1 quality at a small wastewater treatment plant, and reuse at the community, or neighborhood, scale via a reclaimed water distribution system that would be separate from the centralized reclaimed water system. This strategy would provide water for non-drinking water demands such as irrigation, landscaping, cooling, toilet, and potentially also clothes washing. Facilities may be located at the site of existing local WWTPs, or at new potential sites. Distributed wastewater treatment plants evaluated for Water Forward were sized to manage peak wet weather flows into the wastewater collection system and also to meet demand for reclaimed that would be produced by the plants. Reuse from this option is not considered for outdoor end uses in Critical Water Quality Zones, floodplains, or the Edwards Aquifer Recharge Zone. Initial implementation steps for this strategy will include additional refinement of geospatial analysis and potential project identification. Later steps will include design and construction of projects. Potential implementation issues for distributed wastewater reuse include challenges with public opinion, the need for public education on water safety, and changing behavior to promote usage of the reuse water.

7.2.10 Community Scale Sewer Mining

Sewer mining (or local wastewater scalping) is defined as the extraction of wastewater from the existing centralized wastewater collection system, treatment to treatment to non-drinking water quality at a small wastewater treatment plant, and reuse at the community scale via a reclaimed water distribution system that would be separate from the centralized reclaimed water system. A sewer mining treatment plant would be situated close to both the demand and to the sewer extraction point, to reduce piping and pumping costs. This option can be located either within existing open space or within a new development. This strategy would provide water for non-drinking water demands such as irrigation, landscaping, cooling, toilet, and potentially also clothes washing. Wastewater treatment plant wastes (sludge) from the treatment process are assumed to be discharged back to the centralized wastewater collection system for subsequent treatment at the downstream WWTPs. Potential implementation issues for sewer mining include challenges with public opinion, the need for public education on water safety, and changing behavior to promote usage of the water.

7.2.11 Community Stormwater Harvesting

Stormwater harvesting is defined for the purpose of this project as the collection of excess stormwater runoff from urban areas (e.g. impervious surfaces including roads, pavement, and roofs), for treatment and reuse for irrigation/landscaping or reuse for dual pipe systems at the community, or neighborhood, scale.

Implementing stormwater harvesting in new developments provides an opportunity to plumb buildings with purple pipe internal connections for toilet flushing, clothes washing or to cooling towers. Retrofitting existing buildings with internal connections to a dual supply source can be cost prohibitive and/or practically difficult, and so it is assumed for the purposes of this study that stormwater harvesting for existing developed areas would be used solely for irrigation/landscaping of public open space**.** Where used for irrigation/landscaping only, it is assumed that the stormwater will undergo filtration. Where used to supply indoor non-potable end-uses, it is assumed UV disinfection is also required. Storage is assumed to be an underground tank/cistern or more typically open storage such as a wet-pond. Potential implementation issues for community stormwater harvesting include changing behavior to promote usage of the water.

7.2.12 Community Rainwater Harvesting

Community, or neighborhood, scale rainwater harvesting is defined for the purpose of this project as the collection of roof water from new development areas from a dedicated (dual) roof water drainage network for storage at a central downstream location, for treatment and reuse via dual pipe systems at new developments at the community scale. This is assumed to require UV disinfection. Storage is assumed to be an underground tank/cistern. Potential implementation issues for community rainwater harvesting include changing behavior to promote usage of the water.

7.2.13 Conventional Groundwater

There are several groundwater aquifers, including the Edwards, Trinity, and Carrizo-Wilcox aquifers in the region. This option would rely on fresh groundwater sourced from the Carrizo-Wilcox to the east of Austin. This option is considered an imported water supply option and assumes that Austin Water would acquire groundwater permits through the requisite Groundwater Conservation District(s) and develop all source water, treatment and disposal infrastructure. Potential implementation issues for obtaining conventional groundwater supply include challenging permitting and regulatory issues and blending with current supply sources and chemical interaction between waters.

7.2.14 Other Options Re-Categorized in the Planning Process

The following options were originally considered for screening but were later determined to fall outside of the typical option classifications. "Lake Austin Operations" is recommended in this plan as a best management practice option while "Regional Partnerships" is categorized as a potential implementation option.

- **Lake Austin Operations:** Instead of being screened, this option was determined to be a best management practice drought response approach. The operational drought strategy involves varying the Lake Austin operation level during non-peak months (Oct-May) and after combined storage in the Highland Lakes falls below 600,000 AF. This strategy would allow local usage to draw the lake down to a maximum of three feet in order to catch runoff from local storm events. This approach would allow for use of this runoff, as opposed to excess runoff spilling over Tom Miller Dam to flow downstream. This strategy was assumed as part of the baseline water supply for the IWRP.
- **Regional Partnerships:** This option was determined to be an implementation strategy of other supply options on the screening list and was not screened individually. Regional partnership strategies could be considered when implementing water supply options.

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SECTION 8: PORTFOLIO EVALUATION

In order to meet the goals of the IWRP process, including ensuring long-term resiliency, supply diversification, and sustainability in meeting the identified needs, groupings of options called portfolios were developed and evaluated. Portfolios are different combinations of options aimed at meeting needs. Dozens of potential portfolios can be developed by grouping various options. Thus, a structured evaluation process for defining and evaluating portfolios, described in more detail below, was used.

The portfolio evaluation process began with a method using themes around which options were combined to form initial portfolios, such as “maximizing conservation” or “maximizing local control”. Thematic portfolios are often designed so that they push boundaries, as illustrated in **Figure 8-1.**, thus allowing trade-offs to be more easily seen as part of evaluation. For example, if an initial portfolio maximized water reliability, what would be the impact on cost or environmental impact? If another initial portfolio maximized local control, what would be the impact on implementation or social benefits? For the IWRP, five initial thematic portfolios were developed centered around maximizing certain objectives that were informed by public feedback to see relative trade-offs.

Figure 8-1. Initial Portfolios Centered Around Themes to Push Boundaries and See Trade-Offs

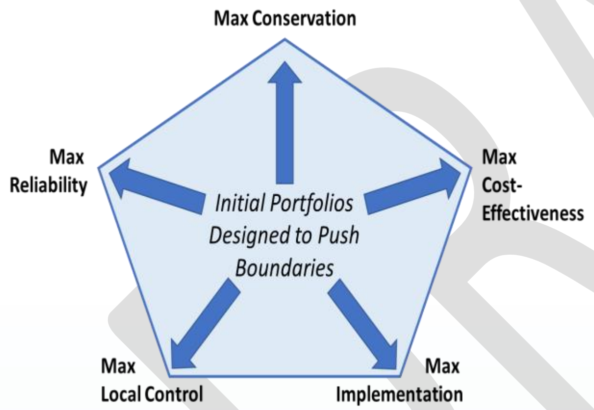
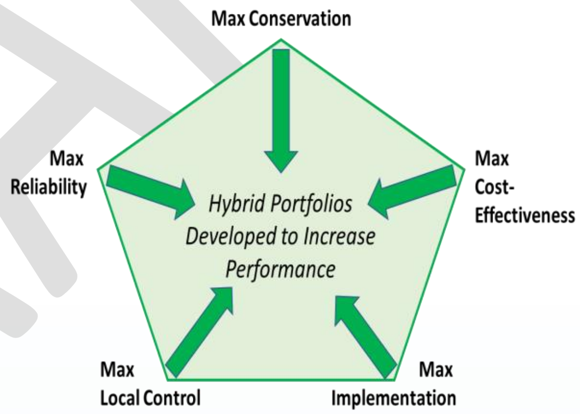


Figure 8-2. Process to Develop Hybrids



Each of these initial portfolios were comprehensively assessed in terms of how well they provided water supply, environmental, economic, and social benefits. In addition, the portfolios were evaluated in terms of implementation risks and benefits. Based on evaluation of the initial portfolios, two hybrid portfolios were developed (see **Figure 8-2.**). The intent of the hybrid portfolios was to extract the best-performing traits from the initial portfolios while minimizing those aspects that were less desirable—thus creating new portfolios with higher performance.

AT A GLANCE

- *Portfolio Definitions*
- *Raw Performance Scorecard*
- *Portfolio Rankings*
- *Summary of Findings*

8.1 Portfolio Definitions

As presented in the intro, five initial portfolios were developed around objective-based themes. The themes were based on public feedback received through the Water Forward outreach process and represent maximizing portfolio performance for certain key objectives without worrying about the performance of another important objective. This approach allowed the initial portfolios to push the boundaries of the plan objectives to see the outcomes of portfolios with a single-objective focus, which allowed for a clearer analysis of trade-offs between objectives. The five initial portfolio themes were developed based on Austin Water, community, and Task Force input. Two hybrid portfolios were then developed which represent a more balanced approach to meeting multiple objectives. Descriptions of the portfolio themes are provided in **Table 8-1..**

Table 8-1. Portfolio Themes and Descriptions

Portfolio Theme	Description
Maximize Cost-Effectiveness	Options with the lowest unit costs ($/acre-foot/year) were generally selected.
Maximize Local Control	Options which are locally sourced or which Austin Water would have control over the projects and the water supplies in terms of cost, yield, development, and operations were generally selected.
Maximize Implementation	Options that have a higher degree of potential implementation success were generally selected.
Maximize Reliability	Options that provide higher supply reliability and resiliency in terms of climate and hydrology were generally selected.
Maximize Conservation	Options that conserve water and maximize the reuse of treated wastewater and stormwater were generally selected.
Hybrid 1	Built from the initial Maximize Conservation portfolio with the intent of increasing water supply benefits, while not significantly impacting the environmental and social benefits. This was achieved by increasing storage and reuse options.
Hybrid 2	Built from the initial Maximize Reliability portfolio with the intent of increasing environmental and social benefits, while reducing cost and risk. This was achieved by increasing demand management options, scaling back on seawater desalination and eliminating direct potable reuse.

The IWRP process included a key step to quantify projected future identified water needs. Quantifying projected future identified water needs (discussed in more detail in **Appendix F**) was important in that it established the volume of water the plan needed to address through demand management and water supply strategies. In addition to identifying the volume of projected need, the Water Forward process identified the type of projected need—Type 1, Type 2, or Type 3. The different types of need are described in more detail in **Appendix F** and in **Section 5.1**, but can briefly be described as needs associated with water restrictions during drought (Type 1), needs associated with regional shortages in deep drought (Type 2), and need associated with water demands above Austin Water's existing water supply contract with LCRA (Type 3). Identifying different "types" of need provided more control when selecting options for portfolios, as certain options were defined as being able to meet certain "types" or need—for example, building-scale wastewater reuse as defined in Water Forward cannot be used to meet Type 2 needs since it does not provide a new potable water source, and Type 2 needs need to be met by options that can provide potable water.

After identifying the volumes and types of needs, goals for portfolio performance related to water supply reliability were developed to assist in grouping options into portfolios. The initial portfolios were developed with the following goals:

1. Meet all identified water needs (Types 1, 2, and 3) reliably for the period of record with historical climate (hydrologic scenario A).
2. Meet most identified water needs (Types 1, 2, and 3) for the period of record with climate change (hydrologic scenario B).
3. Assess how well identified water needs (Types 1, 2, and 3) are met with extended period with climate change (hydrologic scenario D).

The hybrid portfolios were developed with the following goals:

1. Meet all identified water needs (Types 1, 2, and 3) reliably for the period of record with historical climate and with climate change (hydrologic scenario A & B).
2. Meet most identified water needs (Types 1, 2, and 3) with extended period with climate change (hydrologic scenario D).

For reference, **Table 8-2.** Baseline shows the baseline identified water needs over time, as estimated by Austin Water's WAM for the hydrologic scenario B (period of record hydrology with climate change).

Table 8-2. Baseline 12-Month Identified Water Needs (AFY) for Period of Record w/ Climate Change

Water Need Type	2020	2040	2070	2115
Type 1 - Water need in an amount equal to the estimated savings from City's Stage 4 Drought Contingency Plan implementation [1]	3,000	10,600	15,400	24,800
Type 2 - Fifty percent of the amount of water Austin expects to receive from LCRA supply when combined storage in Lake Travis and Buchanan is extremely low (less than 450,000 acre-feet or about 22% full)[2]	6,000	20,400	77,000	93,600
Type 3 – Amount of water above Austin Water's current LCRA contract of 325,000[1]	0	0	0	170,400
Total Baseline Water Needs	**9,000**	**31,000**	**92,400**	**288,800**

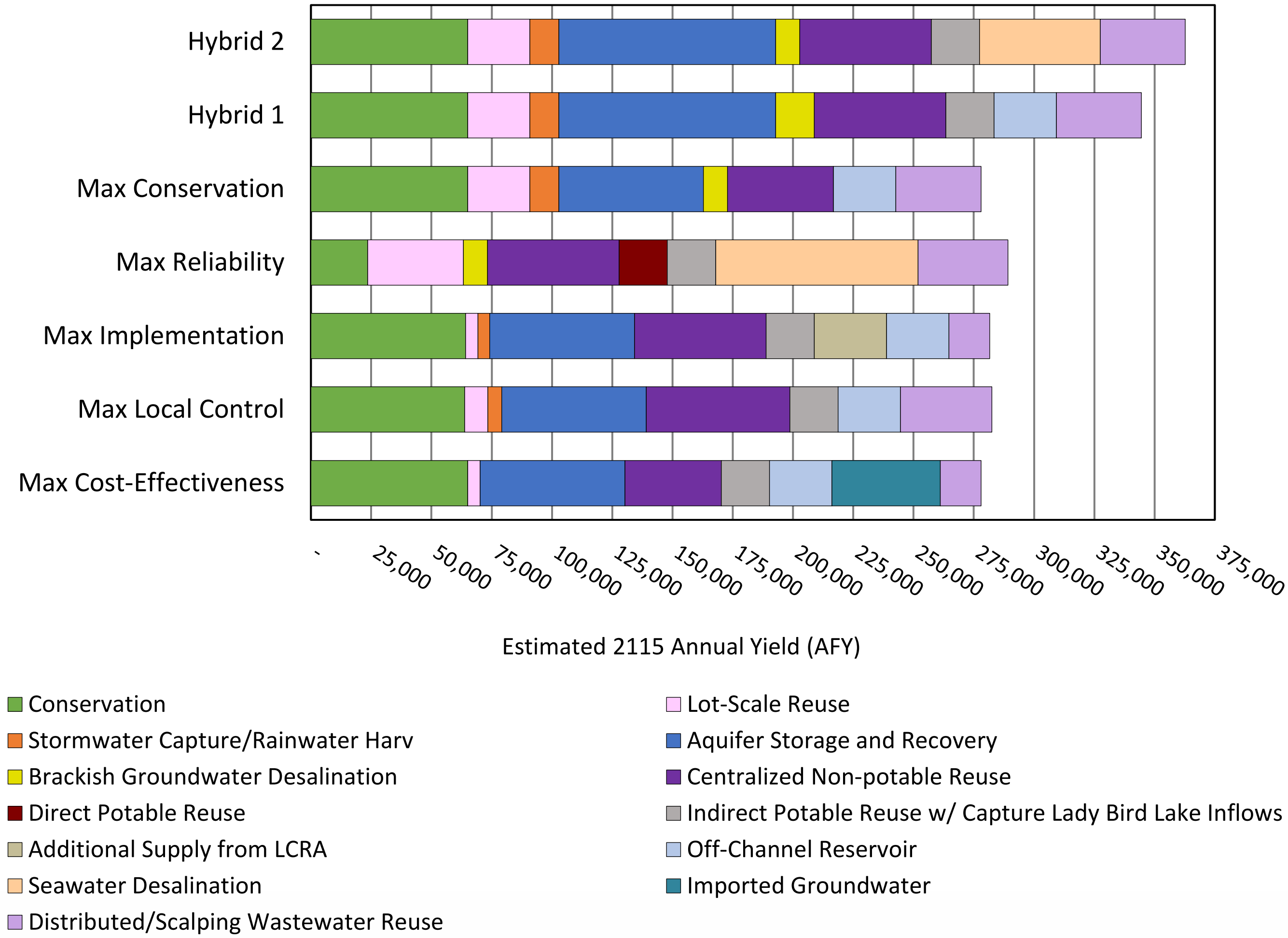
AFY = acre-feet per year
[1]Need can be achieved with new demand management and water supply options.
[2]Need can only be achieved with new water supply options resulting in readily available potable water.

Table 8-3. indicates which demand management and water supply options were included in each portfolio, while **Figure 8.4** shows the maximum annual water yield for portfolio options in the year 2115. Additional detail on the cost and yield of each option is included in **Appendix J**, and overall portfolio cost and yield metrics can be reviewed in **Appendix L**. Note that the options included in each portfolio are in addition to the City's current Colorado River water supplies, current reclaimed water supplies, and current conservation programs. These baseline supplies are the underlying core supplies present in every portfolio.

Table 8-3. Summary of Options Included in Portfolios

Options	Included in Portfolios						
	Max Cost-Effective	Max Control	Max Implem.	Max Reliability	Max Conserv.	Hybrid 1	Hybrid 2
Demand Management Options							
Advanced Metering Infrastructure	X	X	X	X	X	X	X
Water Loss Control Utility Side	X	X	X	X	X	X	X
CII Ordinance for Cooling Towers and Steam Boilers	X	X	X	X	X	X	X
Water Use Benchmarking and Budgeting	X	X	X		X	X	X
Landscape Ordinance	X	X	X		X	X	X
Landscape Incentives	X				X	X	X
Irrigation Efficiency Incentives	X		X		X	X	X
Stormwater Harvesting (Lot)					X	X	X
Rainwater Harvesting (Lot)		X	X		X	X	X
Graywater Harvesting (Lot)		X		X	X	X	X
Building Scale Wastewater Reuse				X	X	X	X
AC Condensate Reuse	X	X	X	X	X	X	X
Water Supply Options							
Aquifer Storage and Recovery	X	X	X		X	X	X
Brackish Groundwater Desal				X	X	X	X
Direct Non-Potable Reuse	X	X	X	X	X	X	X
Direct Potable Reuse				X			
Indirect Potable Reuse with Capture Local Inflows to Lady Brid Lake	X	X	X	X		X	X
Additional Supply from LCRA			X				
Off-Channel Reservoir w/ Lake Evaporation Suppression	X	X	X		X	X	
Imported Option Category - Seawater Desalination				X			X
Imported Option Category – Conventional Groundwater	X						
Distributed Wastewater Reuse	X	X	X	X	X	X	X
Wastewater Scalping (Sewer Mining)		X		X	X	X	X
Community Stormwater Harvesting		X			X	X	X
Community Rainwater Harvesting		X					

Figure 8-3 Estimated Annual Water Yield (AFY) in Year 2115 for Each Portfolio



All portfolios met all identified water needs (Types 1, 2, and 3) for the period of record hydrology with historical climate (hydrologic scenario A). Of the initial themed portfolios, only the Maximum Reliability portfolio came close to meeting all identified needs under period of record with climate change (hydrologic scenario B) and extended period hydrology with climate change (hydrologic scenario D). Both Hybrid 1 and 2 portfolios met all identified water needs under hydrologic scenario B and came close to meeting all identified water needs for hydrologic scenario D.

8.2 Raw Performance Scorecard

As outlined in Section 3.5, the IWRP had five major objectives against which the portfolios were evaluated: (1) *Water Supply Benefits*; (2) *Economic Benefits*; (3) *Environmental Benefits*; (4) *Social Benefits*; and (5) *Implementation Benefits*. These five objectives were further defined by sub-objectives. For example, the objective *Water Supply Benefits* had two sub-objectives: *Vulnerability* and *Reliability*. No objective had more than three sub-objectives. Primary weights of relative importance were assigned to each of the five objectives and secondary weights of relative importance were assigned to each of the twelve sub-objectives (see **Table 8-4.**).

Table 8-4. Objective and Sub-Objective Weights

Objective	Sub-Objective
Water Supply Benefits – **35%**	Minimize Vulnerability – **80%**
	Maximize Reliability – **20%**
Economic Benefits – **20%**	Maximize Cost-Effectiveness – **75%**
	Maximize External Funding – **25%**
Environmental Benefits – **20%**	Minimize Ecosystem Impacts – **40%**
	Minimize Net Energy Use – **30%**
	Maximize Water Use Efficiency – **30%**
Social Benefits – **13%**	Maximize Multi-Benefit Programs – **38%**
	Maximize Net Benefits to Local Economy – **31%**
	Maximize Social Equity – **31%**
Implementation Benefits – **12%**	Minimize Risk – **60%**
	Maximize Local Control/Local Resource – **40%**

For each sub-objective, performance metrics were established to measure how well the portfolios achieved the sub-objective. Several performance metrics were quantitative and based on modeling or detailed evaluations. The quantitative performance metrics were measured on a continuous scale (e.g., dollars); or in some cases measured on a qualitative scale from one to five, as described in the objective matrix in Section 3, Table 3-2, based on quantitative measurements (referred to as “qualitative based on quantitative”). Other performance metrics were qualitative and measured on a scale from one to five based on expert judgement. For metrics which were not purely quantitative, a score of one indicated poorer performance in that area and a score of five indicated higher performance in that area.

Table 8-5. summarizes the objectives, sub-objectives and performance metrics for the portfolios. A description of how the performance metrics were derived follows. **Appendix L** contains further details about the various metrics used in portfolio evaluation and their values.

Table 8-5. Raw Performance Scorecard

Objective	Sub-Objective	Performance Metric	Metric Type	Portfolio						
				Max Cost-Effect.	Max Control	Max Implem.	Max Reliable	Max Conserv.	Hybrid 1	Hybrid 2
Water Supply Benefits	Minimize Vulnerability	% of identified needs met during 12-months of worst-case drought[1]	Quantitative (WAM)	81%	77%	77%	95%	76%	89%	92%
	Maximize Reliability	% of months in period of simulation with no identified need shortages[1]	Quantitative (WAM)	93%	97%	97%	98%	97%	100%	100%
Economic Benefits	Maximize Cost-Effectiveness	Lifecycle unit cost ($/AF)[2]	Quantitative (Eng. Estimate)	$1,513	$1,914	$1,540	$3,434	$2,753	$3,150	$3,197
	Maximize External Funding	Grants and developer funding potential (score 1-5)[3]	Qualitative	1.7	2.4	1.8	4.0	3.6	3.6	3.5
Environmental Benefits	Minimize Ecosystem Impacts	Ecosystem impact, net diversions and stormwater capture (score 1-5)[2,3]	Derived from WAM	1.4	2.7	1.7	2.7	4.6	4.0	4.7
	Minimize Net Energy Use	Net change in energy requirement (millions of kWh/yr)[2]	Quantitative (Eng. Estimate)	125	66	48	315	97	144	282
	Maximize Water Use Efficiency	2115 potable water per capita demand (gallons/person/day)[2]	Quantitative (demand model)	79	68	75	73	67	65	65
Social Benefits	Maximize Multi-Benefit Programs	Stormwater capture/harvesting (score 1-5)[2,3]	Derived from Portfolio Mix	3.1	3.7	3.6	1.0	4.7	4.7	4.7
	Maximize Net Benefits to Local Economy	Positive economic impact (score 1-5)[2,3]	Derived from Cost Estimate	1.0	2.1	1.1	5.0	4.4	5.0	4.6
	Maximize Social Equity	Social equity score (score 1-5)[3]	Qualitative	3.1	3.3	3.5	2.9	3.4	3.3	3.3
Implementation Benefits	Minimize Risk	Portion of supply mix considered relatively high in risk (score 1-5)[3]	Qualitative	3.6	4.8	5.0	1.0	4.9	4.4	3.4
	Maximize Local Control/Local Resource	Portion of supply mix within local area and/or within AW's control of operations (score 1-5)[3]	Derived from Portfolio Mix	2.4	3.2	2.8	1.0	2.36	5.0	4.8

[1]Calculated by taking geometric mean of WAM results for hydrologic scenarios B and D; and for years 2040, 2070, and 2115.
[2]Based on period of record with climate change (scenario B).
[3]Score of 1 = lower relative performance, while score of 5 = higher relative performance

8.2.1 Water Supply Benefits

The water supply benefits objective was based on two sub-objectives: supply reliability and vulnerability. Supply reliability was calculated as the percent of months without Type 1, 2, or 3 shortages during the period of simulation, and supply vulnerability was calculated as how much of the Type 1, 2, and 3 water needs are met during the 12-months of worst-case drought. Performance metrics under the water supply benefits objective were calculated using output from Austin Water's Water Forward WAM. For each portfolio, the model was run under hydrologic scenarios B and D (period of record with climate change and extended period with climate change, respectively) for the 2040, 2070 and 2115 planning horizons. Both the vulnerability metric and reliability metric were estimated by taking the geometric mean for hydrologic scenarios B and D, throughout the planning period. **Appendix L** contains more detail on how the water supply benefits sub-objective metrics were calculated.

8.2.2 Economic Benefits

The economic benefits objective was determined based on portfolio performance for two sub-objectives: a portfolio's cost-effectiveness and a portfolio's potential for advantageous external funding. The two sub-objectives were measured by estimating a simplified lifecycle unit cost and a qualitative assessment of advantageous funding, respectively.

The simplified lifecycle unit cost was estimated using a levelized unit cost based on unit costs developed in option characterization (detailed cost assumptions for each option can be found in **Appendix J**) that considered whether the option was modeled to be operating constantly or only when needed. The operation and maintenance (O&M) costs for options that are not operated constantly are lower than those that are, but the tradeoff is the yield of the intermittently operated options is not constant. The levelized unit cost used to measure portfolio cost-effectiveness takes both the cost and yield into account to evaluate trade-offs between options and generate an overall portfolio cost-effectiveness score that accurately represents relative performance.

The maximizing advantageous external funding sub-objective considered two factors: (1) the likelihood that a project projected to be owned and operated by AW could receive outside funding (e.g. loans, grants, or other) and (2) the potential for project implementation and operation costs to be borne by developers. For the external funding component, each option was qualitatively scored on a scale of one to five and then weighted based on the yields of each option. The score for potential developer contribution was based on the total cost of options seen as having potential for developer contribution. The final score for advantageous external funding was then determined as 40% the external funding score and 60% the developer contribution score. See **Appendix L** for more details on how each economic benefits sub-objective score was determined.

8.2.3 Environmental Benefits

The environmental benefits objective was calculated based on three sub-objectives: ecosystem impacts, net energy use, and water use efficiency. **Appendix L** provides more detail on how each of the sub-objectives for the environmental benefits score were calculated, as well as values for the various metrics used.

The ecosystem impact score was based on net diversions outputted from the WAM for hydrologic scenario B (period of record with climate change) and the total volume of stormwater or rainwater harvesting a portfolio contained. When the net diversion results for all portfolios were compared, they did not vary greatly from one portfolio to the next, but to increase relative differentiation in the portfolios and to follow process steps, they were scored one a full one-to-five scale. For the stormwater and rainwater harvesting volume, total yields of the stormwater and rainwater harvesting options in a portfolio were determined and used to assign a scaled one-to-five score. The average of the net diversion and stormwater/rainwater harvesting scores was then calculated to give the raw performance score.

The incremental change in energy use sub-objective considered the additional energy, as compared to today's baseline, needed to operate each option in a portfolio and the energy savings associated with reduced need for potable water treatment due to demand management options. A portfolio's score was the summation of additional energy use or savings from each option in millions of kWh per year. Since the sub-objective is to minimize net energy use, a lower score was better for this performance measure.

The sub-objective to maximize water use efficiency was measured as the potable water use of the portfolio in gallons per capita per day (GPCD) at the 2115 planning horizon. Total 2115 projected Colorado River diversions from the disaggregated demand model (see Section 4.1 for more detail on the disaggregated demand model) were converted to treated potable water pumpage. The potable water pumpage was then divided by the estimated 2115 population to obtain an estimate for 2115 GPCD. For this performance measure, a lower GPCD is better since it indicates a more efficient use of potable water.

8.2.4 Social Benefits

The social benefits objective was measured by assessing portfolio performance for maximizing multi-benefit infrastructure, benefits to the local economy, and social equity. Options which provided stormwater harvesting, rainwater harvesting, or landscape transformation benefits were used as proxies for options which would increase multi-benefit infrastructure. To score portfolios based on maximizing the multi-benefit infrastructure options they contained, the total volume supplied from the proxies for each portfolio was summed and then assigned a scaled score based on the result. **Appendix L** contains more detail on how this metric and the others discussed in this section were calculated.

The score for maximizing benefits to the local economy was based on options that have the potential to bring economic benefit or work to the local area. While all options characterized for Water Forward would likely contribute some benefit to the local economy, this sub-objective focused on those options with the highest potential to generate local economic activity. This could include options having locally-based construction or options which would promote Austin as a center for innovative water infrastructure. The yield from each of the options seen as benefiting the local economy was multiplied by its unit cost and the totals were summed for each portfolio. These dollar figures were then converted to a scaled score, as outlined in the objective matrix in **Appendix L**.

The social equity sub-objective score is based on an Equity Analysis Worksheet provided by the City of Austin Equity Office. This worksheet is an adaptation of the Equity Assessment Tool, which lays out a process and a set of questions to guide city departments in evaluating policies, practices, budget allocations, and programs and begin addressing their role and impacts on equity. Each option received a total composite score based on evaluation using this worksheet. The total composite scores were then scaled to align with the objective matrix.

8.2.5 Implementation Benefits

The implementation benefits objective was scored through a combination of assessment of overall risk and the amount of local control or local resources a portfolio would have. The risk score was based on the percentage of a portfolio's yield coming from higher-risk options. Higher-risk options were determined by evaluating each option against ten different types of risk (institutional challenges, public/developer opposition, scalability issues after construction, geographic/distribution limitations, permitting/regulatory difficulty, infrastructure failure risks, supply/savings uncertainty, operations and maintenance challenges, siting/land acquisition challenges, and emerging technology/local innovation challenges).

The local control/local resource sub-objective score was based on two metrics: the portfolio yield from options that AW would likely control and the portfolio yield from options located locally. The two yields were summed together, which helped indicate which portfolios had a high degree of both locally-controlled options and locally-sourced options. This combined value for each portfolio was then converted into a scaled score. **Appendix L** contains more detail on how all the implementation benefits metrics were calculated and how each portfolio scored.

8.3 Portfolio Rankings

Using the raw performance scores shown previously in **Table 8-5.** Raw Performance Scorecard and the weights determined for objectives and sub-objectives, the portfolios were evaluated and scored by the decision software Criterium Decision Plus, using the multi-attribute rating method described in more detail in **Section 3.7.3.2**. The portfolios were ranked based on the relative importance of each objective and sub-objective, as defined by the objective matrix, and how they performed within each of those objectives. **Figure 8-4.** Scoring of Portfolios Using Decision Software shows the ranking of portfolios. The figure not only shows which portfolios ranked the highest but also which objectives contributed the most to the scoring. The larger the color bar segment, the better the portfolio does in achieving a particular objective. Further detail on the scoring of each objective and sub-objective is presented in **Appendix L**.

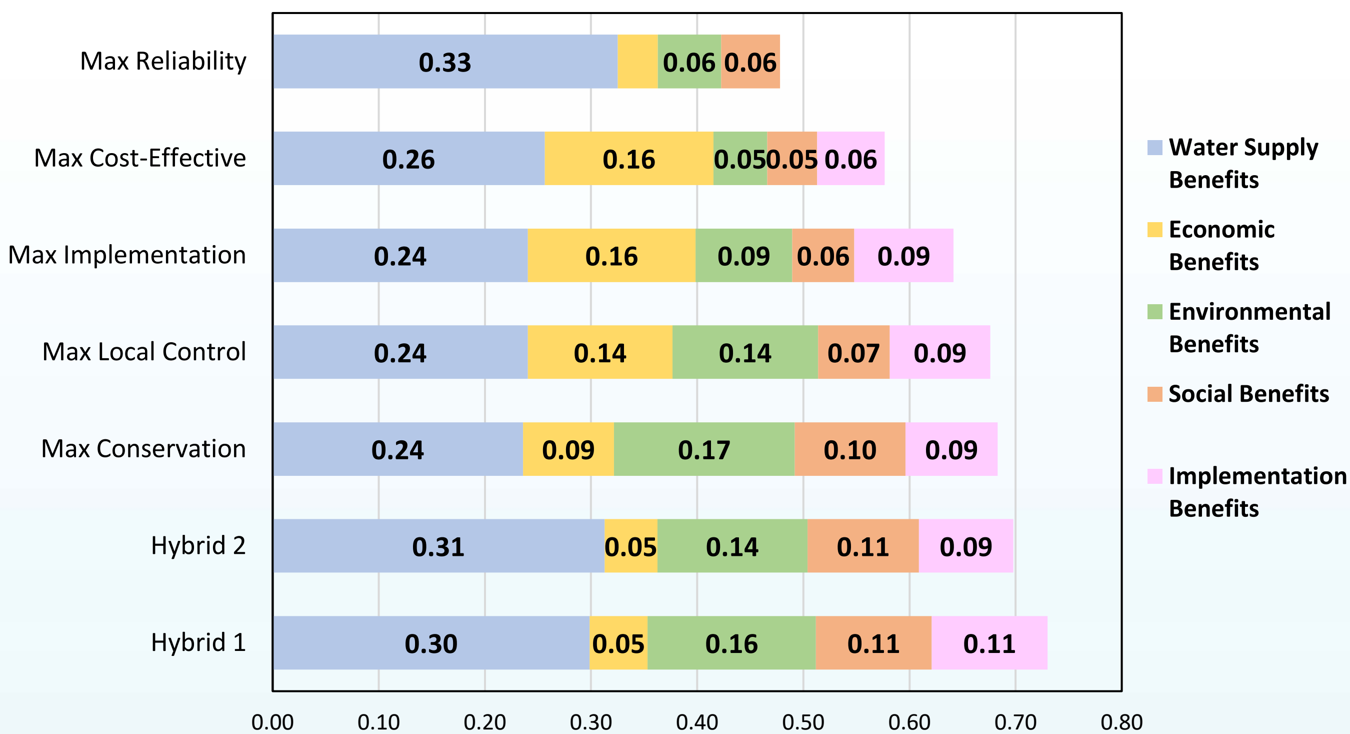


Figure 8-4. Scoring of Portfolios Using Decision Software

8.4 Summary of Findings

The results presented in **Figure 8-4.** show quite a bit of variability among the portfolios evaluated. The Maximum Reliability portfolio had the best overall score for water supply benefits, but it scored lowest overall due to its higher cost and implementation risk, and lower environmental and social benefits. The Maximum Cost-Effectiveness portfolio scores somewhat higher for economic benefits than the other portfolios and is tied with the Maximum Implementation Ease portfolio for economic benefits.

The figure also shows that the Hybrid 1 portfolio scored highest among all the portfolios evaluated, while the Hybrid 2 portfolio scored second. Of the initial portfolios, the Maximum Conservation portfolio scored third. The fact that the Hybrid 1 and Hybrid 2 portfolios were the highest-scoring aligns with the methodology used, since they were based on improvements made to initial portfolios. Because Hybrid 1 had the highest overall composite score, it was chosen to form the basis for Water Forward plan recommendations. Hybrid 1 represents the best mix of options to meet the city's identified needs and objective. The next section includes the plan recommendations that resulted from the portfolio evaluation and plan development process.

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SECTION 9: RECOMMENDATIONS

The comprehensive evaluation of the five initial and two hybrid portfolios presented in **Section 8:** identified the Hybrid 1 Portfolio as the highest ranked overall portfolio. The recommended Hybrid 1 portfolio represents the best mix of strategies in meeting the objectives of the integrated water resource plan. The Hybrid 1 portfolio is the basis for Water Forward recommendations that will be implemented through an adaptive management approach, which allows Austin to prepare for a variety of potential futures. The Water Forward recommendations will strengthen Austin's water supply reliability, increase the city's supply diversity, and will prepare the city to manage the effects of climate change, droughts worse than those we have experienced in the past, and other uncertainties in the future.

AT A GLANCE

- *Plan Recommendations*
- *Water Forward Plan Benefits*
- *Water Forward Implementation and Adaptive Management Plan*

9.1 Plan Recommendations

The Water Forward recommendations include new conservation and supply strategies based on the Hybrid 1 portfolio composition. The plan also recommends implementation of best management practices, development of alternative water ordinances, expansion of centralized reclaimed water ordinances, and a continued commitment to Austin Water's water conservation program and to our core Colorado River supplies.

Table 9-1 presents a summary of the Water Forward recommendations from the Hybrid 1 portfolio for new demand management and water supply options, along with the projected yields for these recommended strategies. The following subsections provide a narrative overview of the Water Forward plan recommendations. For more detailed information regarding planned action steps and timeframes, see **Appendix M**.

Table 9-1. Water Forward Recommended Strategies with Planning Horizon Yields

Option #/ Type	Recommended Strategies	Average/ Drought	Estimated Yield (Acre Feet per Year)[1]			
			2020	2040	2070	2115
	Demand Management Strategies					
D1	Advanced Metering Infrastructure (AMI)	Both	600	3,880	5,770	9,370
D2	Utility-Side Water Loss Control	Both	3,110	9,330	10,920	13,064
D3	Commercial, Industrial, and Institutional (CII) Ordinances	Both	1,060	1,060	1,060	1,060
D4	Water Use Benchmarking and Budgeting	Both	-	5,950	11,670	25,230
D5	Landscape Transformation Ordinance	Both	-	3,040	7,430	15,050
D6	Landscape Transformation Incentive	Both	-	320	630	930
D7	Irrigation Efficiency Incentive	Both	40	210	430	390
D8	Lot Scale Stormwater Harvesting	Both	-	330	870	2,280
D9	Lot Scale Rainwater Harvesting	Both	-	1,550	4,030	9,250
D10	Lot Scale Graywater Harvesting	Both	-	2,130	5,620	12,670
D11	Lot/Building Scale Wastewater Reuse	Both	-	1,320	3,670	7,880
D12	Air Conditioning (AC) Condensate Reuse	Both	100	1,080	2,710	5,150
	Demand Management Strategies Sub-Total	-	4,910	30,200	54,810	102,320
	Water Supply Strategies					
S1	Aquifer Storage and Recovery	Drought	-	60,000	60,000	90,000
S2	Brackish Groundwater Desalination	Both	-	-	5,000	16,000
S3	Direct Non-Potable Reuse (Centralized Reclaimed Water System)	Both	500	12,000	25,000	54,600
S1a	Indirect Potable Reuse (IPR) through Lady Bird Lake	Drought	-	11,000	20,000	20,000
S1b	Capture Local Inflows to Lady Bird Lake (infrastructure also included as part of IPR, above)	Average	-	3,000	3,000	3,000
S7	Off Channel Reservoir	Both	-	-	25,000	25,000
S9	Distributed Wastewater Reuse	Both	-	3,150	14,470	30,050
S10	Sewer Mining	Both	-	1,000	2,210	5,280
S11	Community Scale Stormwater Harvesting	Both	-	160	240	500
	Drought Supply Strategies	-	-	71,000	80,000	110,000
	Average/Both Supply Strategies	-	500	19,310	74,910	134,440
	Water Supply Strategies Sub-Total	-	500	90,310	154,910	244,440
	Water Forward Recommend Strategies Overall Total		5,410	120,510	209,720	346,750
	Water Forward Recommended Implementation Strategies to Realize Estimated Yields Above					
	Phase 1 and 2: Water Use Benchmarking and Budgeting Ordinance					
	Phase 1 and 2: Alternative Water Ordinance					
	Expansion of Alternative Water Incentive					
	Phase 1 and 2: Dual Plumbing Ordinance Development					
	Ordinance to Expand Existing Centralized Reclaimed Water Connection Requirements					
	Current Supplies and Conservation					
	Colorado River and Highland Lakes Supply	Both	325,000			
	Drought Contingency Plan	Drought	Varies			
	Austin Water Conservation Programs*	Both	54,320			
	Centralized Reclaimed Water System	Both	3,960			

***Note:** Austin Water conservation program savings were estimated based on savings calculated during 2012-2015

9.1.1 Water Forward Recommendations to Conserve Water

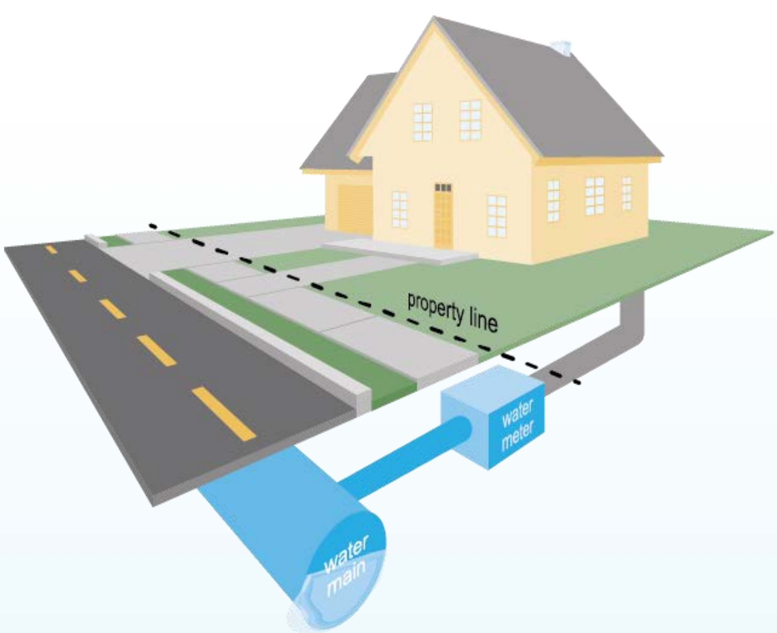
The Water Forward plan includes a robust set of strategies to conserve water, reducing the total volume of water used in Austin, and making our buildings and landscapes more water efficient. These strategies are discussed in the sections below and throughout **Section 9**:. For clarity, the name of each strategy is followed by a number and letter (such as D5) or a brief phrase to allow cross-referencing with

Table 9-1.

9.1.1.1 Advanced Metering Infrastructure (AMI) – D1

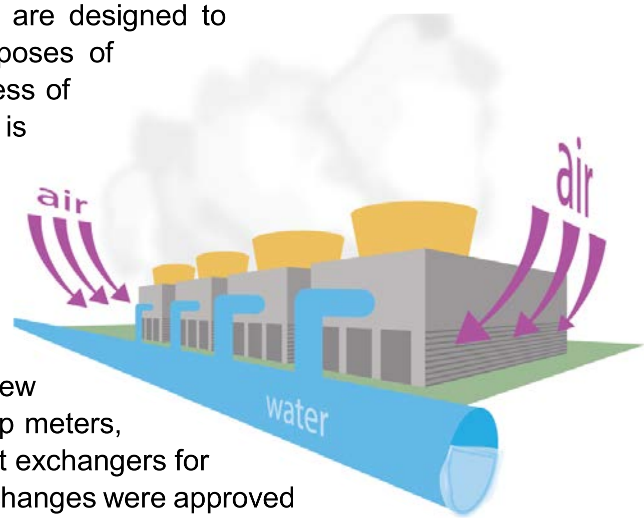
Advanced Metering Infrastructure (AMI), also known as smart meters, record near real-time water use and provides that information to customers through an easy-to-use interface such as a web or a smart phone application. Savings will primarily be achieved through identification of customer leaks, behavior modification, and other water-saving opportunities that are realized because of: (1) improving customer meter accuracy, (2) reducing unauthorized consumption, (3) reducing data transfer/archive errors, and (4) reducing data billing errors. After initial piloting, Austin Water has procured a consultant to assist in scoping the replacement of all retail customer meters with smart meters. Additionally, Austin Water has applied for low-interest loan funding for AMI through the State Water Implementation Fund for Texas. This strategy is targeted to be deployed by 2024, pending Council approval.

9.1.1.2 Utility-Side Water Loss Control – D2



This strategy represents an expansion of Austin's existing water loss program to reduce leaks in the water distribution system. While the target Infrastructure Leakage Index (ILI) for Austin Water is sustaining an ILI at or below 2.7, from fiscal year 2013 to 2015 Austin Water lost an amount of water which equates to an infrastructure leakage index of 3.26. The Water Forward recommendation includes an aggressive leak detection, correction, and prevention program to reduce the ILI to 2.7 by 2020 and further reduce and sustain a 2.0 ILI from 2040 to 2115. Strategies to achieve these targets will include enhancements to existing programs focused on active leak detection, improving response time to leaks, pressure management, and pipeline and asset management selection, installation, maintenance, renewal, and replacement. This strategy may have potential synergies with strategies like Advanced Metering Infrastructure (AMI).

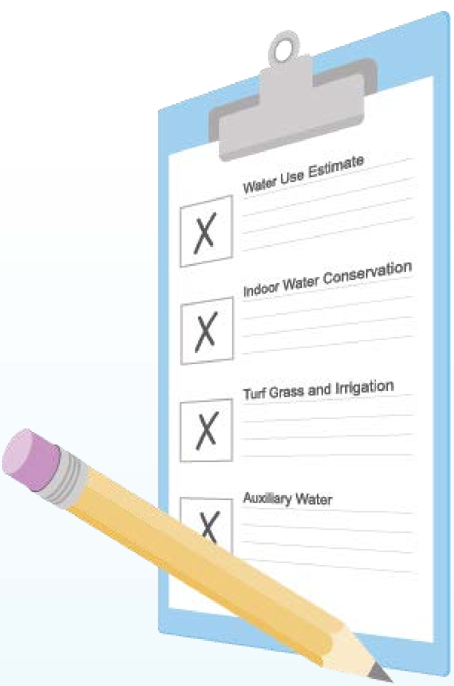
9.1.1.3 Commercial, Institutional, and Industrial (CII) Ordinances – D3



There are over 400 cooling towers in Austin which are designed to remove heat from a building or facility for the purposes of heating, ventilation, and air conditioning. In the process of cooling air, some water is evaporated, and the rest is recycled through the cooling tower. This ordinance requires: (1) all existing and new cooling towers to meet same efficiency equipment standards required for new and replacement towers since 2008 (makeup and blowdown submeters, conductivity controller, drift eliminator and overflow alarm) and achieve five cycles of concentration; and (2) all steam boilers in new development to have conductivity controllers, makeup meters, steam condensate return systems and blowdown heat exchangers for steam boilers. This option is a current program (code changes were approved by Council action in June 2017) and was included as a best management practice as part of the Water Forward plan.

9.1.1.4 Water Use Benchmarking and Budgeting – D4

Water use benchmarking and budgeting uses standards to "benchmark" how much water buildings of a certain size and type would be expected to use. Based on these benchmarks, a "water budget" can be created to track water use in a given building and help users meet their water benchmark. This strategy is planned to be implemented in two phases.



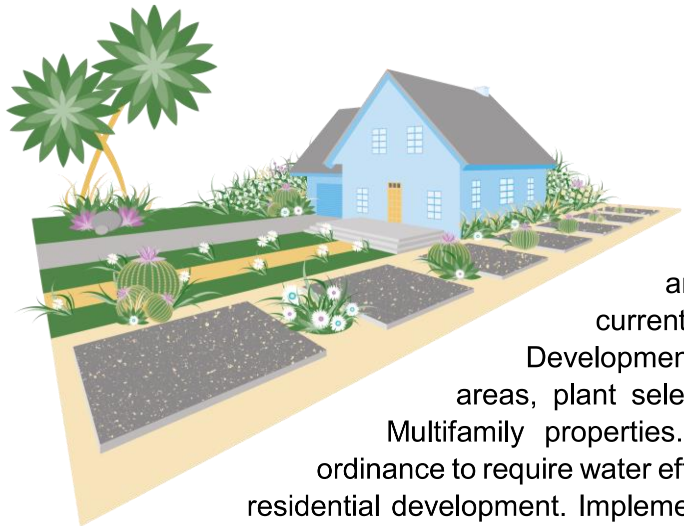
Phase I

Potential approaches to implement this requirement for pre-and post-development of multi-family and commercial facilities will be evaluated and include public outreach, review by Boards and Commissions and Council action.

As part of this program, developers will provide information about all water-using equipment and fixtures associated with the site (including counts), proposed water sources, irrigated area, landscaped area, and other water-use, site, and building characteristics. City staff will provide water efficiency related code requirements, potential water use efficiency best management practices, alternative water recommendations, water use benchmarking data, and information on available incentive and rebate programs for new and existing development. Implementation of the measure will look for ways to tie into the Service Extension Request, Austin Energy's Green Building program, the city's Energy Conservation Audit and Disclosure program, and AMI customer portals for MFR and commercial use.

Phase II

Based on the water use benchmarking data developed through these programs, this strategy will be expanded in the future to include a water use budget for new development constructed after 2025 (compliance mechanism to be determined).



9.1.1.5 Landscape Transformation Ordinance – D5

Landscape transformation is a process of transitioning from traditional landscaping practices to those that rely on regionally appropriate plants and have reduced supplemental water needs, with an emphasis on landscape function. Note that the current Landscape Ordinance in the City of Austin Land Development Code has existing requirements for landscaped areas, plant selection, and irrigation systems for Commercial and Multifamily properties. This strategy includes development of a new ordinance to require water efficient landscapes be installed with new single-family residential development. Implementation of this strategy could include implementing turf grass area, irrigated area, and/or irrigation area limitations. More detailed ordinance concepts and language will be developed through subsequent implementation processes with future additional public input opportunities.

9.1.1.6 Landscape Transformation Incentive – D6

This strategy focuses on incentives for existing development to encourage reductions in water needs for outdoor irrigation through regionally appropriate landscapes with an emphasis on landscape functionality. The current WaterWise landscape rebate offers $35 for every 100 square feet ($0.35/square feet) converted, with a maximum rebate of $1,750 per property. The current program has traditionally had a low participation rate. Implementation of this strategy will explore increasing WaterWise landscape rebates for single-family residential and multi-family residential and implementing a new WaterWise landscape rebate for commercial beyond City of Austin Land Development Code requirements.

9.1.1.7 Irrigation Efficiency Incentive – D7

Outdoor water use comprises over 22% of the water currently used by Austin Water customers with most of that water used for landscape watering. Over 89,000 homes and over 5,000 businesses have irrigation and sprinkler systems, which often are programmed to turn on at certain times of the day without regard to weather or plant water needs. This strategy focuses on expanding existing Austin Water rebate programs to incentivize “smart” irrigation controllers that would improve irrigation system efficiency by responding to leaks, high pressure, and soil moisture and also make flow data accessible.

9.1.2 Water Forward Recommendations to Make Use of Alternative Water

The Water Forward recommendations also include strategies which will help Austin make use of alternative water sources, such as treated rainwater, stormwater, graywater, air conditioning condensate, and highly treated wastewater effluent to meet non-drinking water demands, such as toilet flushing and irrigation. To achieve this, the plan recommends implementation of both ordinances requiring and incentives encouraging the use of these alternative waters at various scales, described below:

- Decentralized lot scale reuse – Including onsite generation, treatment, and reuse of alternative waters to include rainwater, stormwater, graywater, air conditioning condensate, and highly treated wastewater effluent.
- Decentralized community scale reuse – Including collection of alternative waters to include stormwater and wastewater effluent from a cluster of homes or businesses, treatment at locally sited stormwater facilities, distributed wastewater treatment plants, or sewer mining facilities, and reuse via a reclaimed water distribution system that would be separate from the centralized reclaimed water system.
- Centralized reclaimed water system – Including collection of wastewater effluent, treatment at a major wastewater treatment plant, and reuse through connection to the City's centralized reclaimed water distribution system.

All alternative waters recommended in Water Forward are intended to meet non-drinking water demands and are recommended to be backed up by the City's drinking water distribution system. Water Forward recommends that both centralized and decentralized reuse strategies be developed in an integrated manner. As an initial step during the implementation phase, this means using geospatial modeling and analysis to determine the most beneficial alternative source water and most appropriate scale for reuse strategy deployment across the City in a context-sensitive manner.

Increasing the amount of alternative water available to meet non-drinking water demands helps Austin diversify its water supplies and move towards a more resilient system, as illustrated in **Figure 9-1.**. Further description of each of the recommended strategies that will help Austin make use of all its sources of water is provided in the sections below.

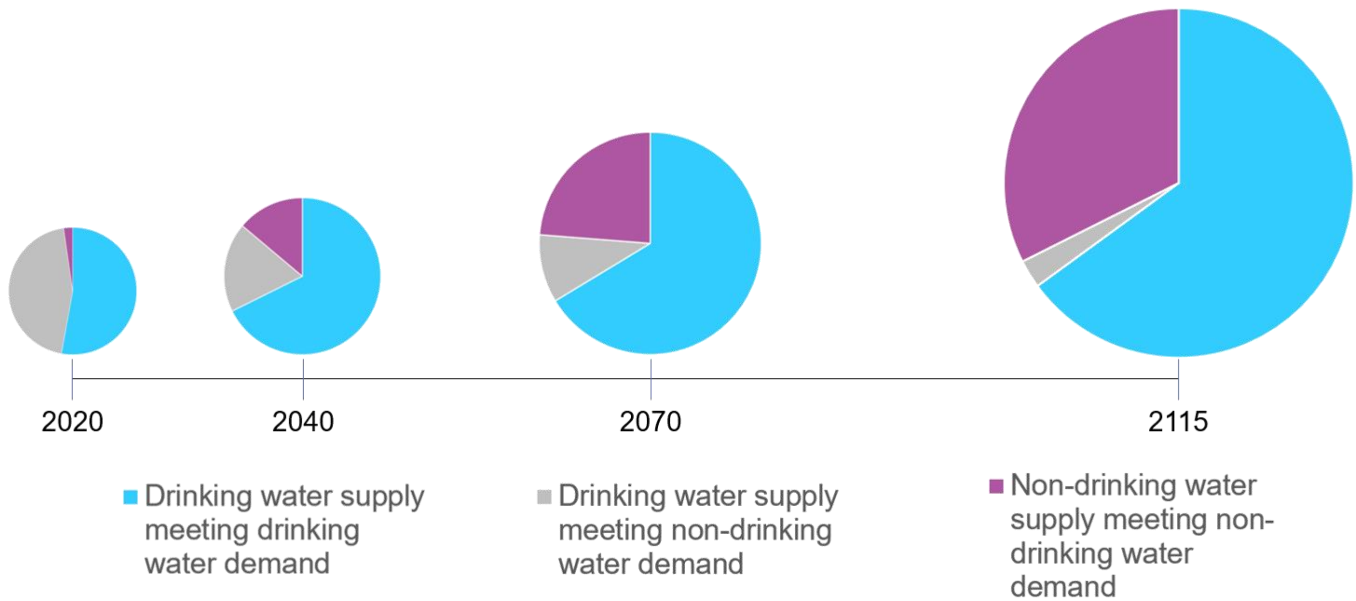


Figure 9-1. Amount of Non-Drinking Water Demand Being Met by Non-Drinking Water Sources Over Time

9.1.2.1 Alternative Water Incentives and Ordinances – D8, D9, D10, D11, S3, S9, S10, S11

Alternative Water Incentive: This strategy will expand existing Austin Water incentive programs to encourage the installation and use of lot scale rainwater harvesting, lot scale stormwater harvesting, lot scale graywater reuse, lot scale blackwater reuse, or community scale stormwater harvesting. Incentive program details will be developed through subsequent implementation processes including interdepartmental coordination.

Alternative Water Ordinance: This strategy includes development of an ordinance to require use of alternative water either generated on-site, such as rainwater, stormwater, graywater, blackwater, air conditioning condensate, or that may be available via the centralized reclaimed and/or decentralized reclaimed systems (decentralized reclaimed includes both distributed wastewater reuse and sewer mining). This strategy is currently planned to be implemented as part of a phased approach.

The initial phase of implementation will explore, through a stakeholder engagement and ordinance development process, requiring use of alternative waters to meet a portion of indoor and outdoor non-potable demands for new large commercial and multifamily buildings (with a potable back-up required). The second phase of implementation will build on the previous phase by exploring, through a stakeholder engagement and ordinance development process, expanding the Phase 1 ordinance's applicability to potentially include mid-size new commercial and multifamily development (with a potable back-up required). See **Table 9-2** for more detail.

Table 9-2. Water Forward Recommended Alternative Water Incentives and Ordinances, Initial Assumptions Related to Specific Strategies

#	Strategy Name	Targeted Sector and End Use (All New Development)	Initial Assumption: Savings Achieved Via Incentive or Ordinance?	2040 (AF/yr)	2070 (AF/yr)	2115 (AF/yr)
D8	Lot Scale Stormwater Harvesting	MFR Outdoor Irrigation	Incentive 50%, Ordinance 50%	180	496	1,391
		COM Outdoor Irrigation	Incentive 50%, Ordinance 50%	149	373	885
D9	Lot Scale Rainwater Harvesting	SFR Outdoor Irrigation	Incentive	937	2,410	5,088
		MFR Outdoor Irrigation	Incentive 50%, Ordinance 50%	54	151	425
		COM Outdoor Irrigation	Incentive 50%, Ordinance 50%	82	209	498
		MFR Outdoor Irrigation and Toilet Flushing	Ordinance	195	556	1,562
		COM Outdoor Irrigation, Toilet Flushing, and Cooling	Ordinance	281	706	1,678
D10	Lot Scale Gray Water Harvesting	SFR Outdoor Irrigation	Incentive	244	631	1,336
		SFR Outdoor Irrigation, Toilet Flushing, and Clothes Washing	Incentive	571	1,461	2,860
		MFR Outdoor Irrigation, Toilet Flushing, and Clothes Washing	Ordinance	991	2,702	6,832
		COM Outdoor Irrigation and Toilet Flushing	Ordinance	321	823	1,638
D11	Lot/Building Scale Wastewater Reuse	MFR Outdoor Irrigation, Toilet Flushing, Clothes Washing, and Cooling	Ordinance	1,323	3,672	7,875
S11	Community Scale Stormwater Harvesting	SFR, MFR, COM, COA Outdoor Irrigation	Incentive	48	48	48
		SFR, MFR, COM, COA Outdoor Irrigation, Toilet Flushing, Clothes Washing, and Cooling	Incentive	109	188	455

9.1.2.2 Air Conditioning Condensate Reuse Ordinance – D12

This strategy, which is already in code, is focused on the collection of air conditioning (AC) condensate water from air handling units (AHUs) from new development with a cooling capacity over 200 tons. The condensate water can be reused for beneficial use for any non-drinking water application including (but not limited to): cooling tower makeup water, irrigation, and indoor toilet flushing. AW will continue to monitor the implementation of this ordinance.

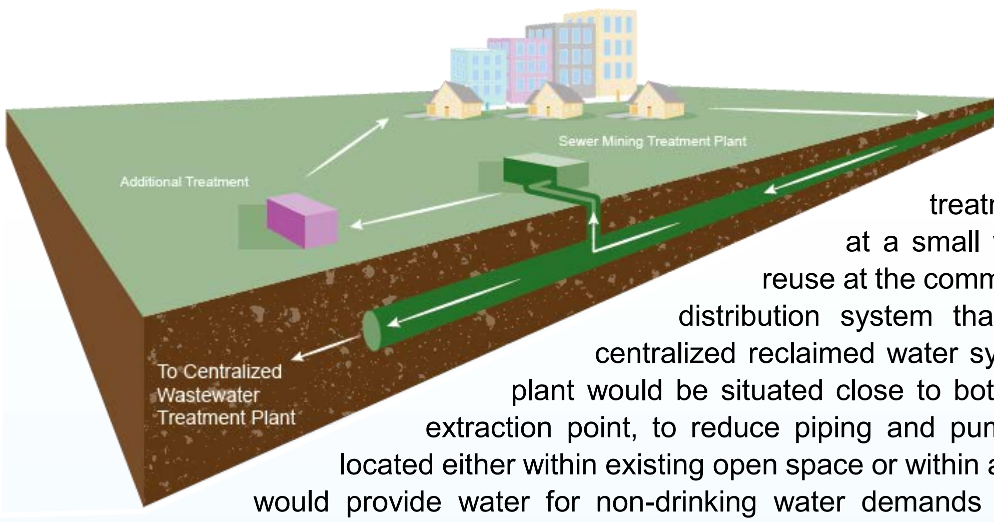
9.1.2.3 Direct Non-Potable Reuse (Centralized Reclaimed Water System) – S3

Through its Water Reclamation Initiative, AW provides highly treated wastewater effluent for non-drinking water uses such as irrigation, cooling, manufacturing, and toilet flushing. As described in **Section 7-17.1.2**, Austin Water has a Water Reclamation Initiative underway, which currently supplies approximately 4,600 AF per year. The direct non-potable reuse strategy recommended in Water Forward includes expansion of this program to provide additional non-potable water supply through the centralized reclaimed water network. This expansion would occur in two phases over the 100-year planning horizon. The first phase would include implementation of the current Reclaimed Water Infrastructure Master Plan (2011) and the program described in the 2016 Lower Colorado Regional Water Plan, with potential modifications necessary to meet 2040 Water Forward yield targets. The second phase would focus on direct non-potable use in anticipated growth areas based on demand model estimates between 2070 and 2115.

9.1.2.4 Community Scale Distributed Wastewater Reuse – S9

Distributed Wastewater Reuse is the collection of effluent from the wastewater system in localized new development areas (completely separate from the centralized wastewater collection system), treatment to non-drinking water quality at a small wastewater treatment plant, and reuse at the community scale via a reclaimed water distribution system that would be separate from the centralized reclaimed water system. This strategy would provide water for non-drinking water demands such as irrigation, landscaping, cooling, toilet, and potentially also clothes washing. Facilities may be located at the site of existing local WWTPs, or at new potential sites. Distributed wastewater treatment plants evaluated for Water Forward were sized to manage peak wet weather flows into the wastewater collection system and also to meet demand for reclaimed that would be produced by the plants. Reuse from this strategy is not considered for outdoor end uses in Critical Water Quality Zones, floodplains, or the Edwards Aquifer Recharge Zone. Initial implementation steps for this strategy will include additional refinement of geospatial analysis and potential project identification. Later steps will include design and construction of projects.

9.1.2.5 Community Scale Sewer Mining – S10



Sewer mining (or local wastewater scalping) is defined as the extraction of wastewater from the existing centralized wastewater collection system, treatment to treatment to non-drinking water quality at a small wastewater treatment plant, and reuse at the community scale via a reclaimed water distribution system that would be separate from the centralized reclaimed water system. A sewer mining treatment plant would be situated close to both the demand and to the sewer extraction point, to reduce piping and pumping costs. This option can be located either within existing open space or within a new development. This strategy would provide water for non-drinking water demands such as irrigation, landscaping, cooling, toilet, and potentially also clothes washing. Wastewater treatment plant wastes (sludge) from the treatment process are assumed to be discharged back to the centralized wastewater collection system for subsequent treatment at the downstream WWTPs. Reuse from this strategy is not considered for outdoor end uses in Critical Water Quality Zones, floodplains, or the Edwards Aquifer Recharge Zone. Initial implementation steps for this strategy will include additional refinement of geospatial analysis and potential project identification. Later steps will include design and construction of projects.

9.1.2.6 Dual Plumbing Ordinance – Implementation Strategy

This strategy is currently planned to be implemented as part of a phased approach. In Phase 1, a stakeholder engagement and ordinance development process will explore requiring dual plumbing for new large Commercial and Multifamily development to facilitate use of alternative water to meet non-drinking water demands (backed up by the City's drinking water distribution system). In Phase 2, a stakeholder engagement and ordinance development process will explore expanding the Phase 1 ordinance's applicability to potentially include mid-size new Commercial and Multifamily development (backed up by the City's drinking water distribution system). These requirements would consider existing indoor centralized reclaimed water use requirements. Implementation of this strategy will include refinement of ordinance scope, applicability, location in code, and enforcement considerations.

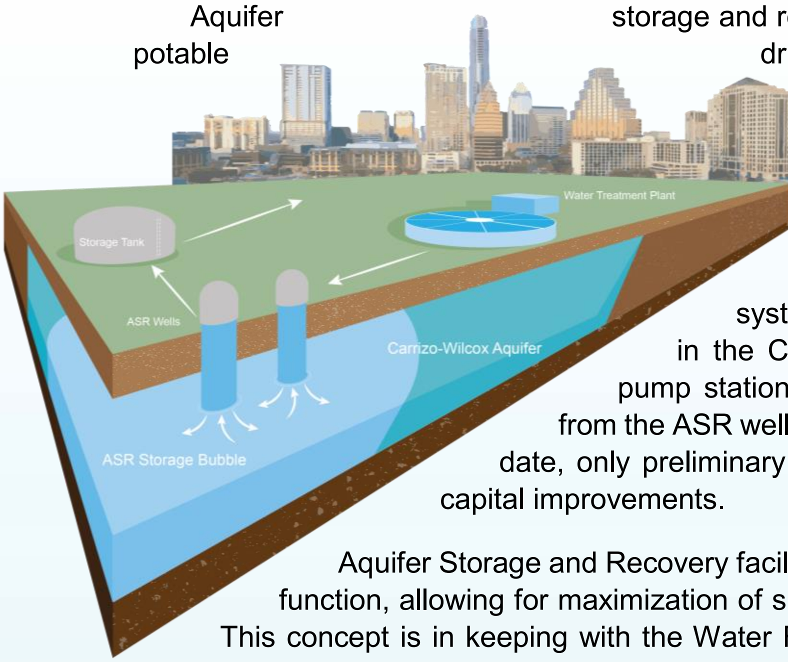
9.1.2.7 Expansion of Current Centralized Reclaimed Water System Connection Requirements – Implementation Strategy

This strategy will explore, through a stakeholder engagement and ordinance development process, expanding existing centralized reclaimed water system connection requirements for new Commercial and Multifamily development. These ordinance changes would assist in achieving the Water Forward Centralized Reclaimed Water System volumetric targets. Implementation of this strategy will include refinement of ordinance scope, applicability, location in code, and enforcement considerations.

9.1.3 Water Forward Recommendations to Increase Potable Drinking Water Supplies

The Water Forward recommendations include several strategies to increase Austin's access to potable water supplies. The major water supply projects included in the plan are recommended largely to augment Austin's access to water during drought when our core surface water supplies are severely limited. Potable water supplies for the purpose of this plan were defined as sources that could be treated to drinking water quality and provided to Austin Water's customers through the potable drinking water distribution system. These recommendations include strategies that will help see Austin through times of deep drought, such as storage and potable reuse options. They also include strategies that help supplement Austin's water supply at all times, such as brackish groundwater, and the ability to capture additional inflows during wet times.

9.1.3.1 Aquifer Storage and Recovery – S1



Aquifer storage and recovery (ASR) is a strategy in which water (ex: potable drinking water) can be stored in an aquifer during wetter periods and recovered for use during drier periods. The Carrizo-Wilcox ASR strategy recommended in Water Forward for implementation by the 2040 planning horizon includes facilities to pipe treated drinking water from the City of Austin's distribution system to an ASR wellfield for injection and storage in the Carrizo-Wilcox aquifer. Facilities also include a pump station and storage tank to convey recovered water from the ASR wellfield to the City of Austin distribution system. To date, only preliminary costs for an ASR pilot are include in the AW capital improvements.

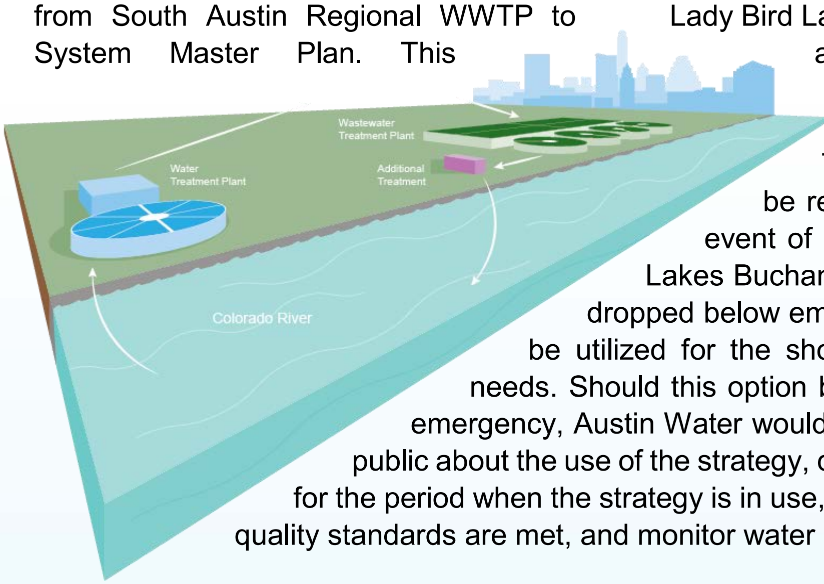
Aquifer Storage and Recovery facilities would be planned to serve solely a storage function, allowing for maximization of surface water resources during drought periods. This concept is in keeping with the Water Forward guiding principle of maximizing locally available water resources. Site selection will depend on favorable hydrogeology to fulfill the ASR facility's intended storage purpose. In implementing this option, Austin Water would work to develop and test a pilot facility to assess potential site characteristics and ensure that the strategy's objective to store surface water in and recover surface from the aquifer is achievable. The ASR strategy is in no way intended to be a strategy to develop native groundwater. To be clear, the ASR injection and recovery wells are in no way intended to pump native groundwater from the Carrizo Wilcox Aquifer and convey that water to Austin via a transmission pipeline.

9.1.3.2 Brackish Groundwater Desalination – S2

Brackish groundwater is recommended in Water Forward for the 2070 planning horizon. Brackish groundwater is defined as groundwater containing between 1,000 and 10,000 milligrams per liter (mg/L) of total dissolved solids. Desalination is often required to remove dissolved solids from brackish groundwater. The specific process used to desalinate water varies depending upon the total dissolved solids, the temperature, and other physical characteristics of the source water, but always requires disposal of concentrate, called brine, that has a higher total dissolved solids content than the source water. Evaporation ponds were assumed to be used for brine disposal. Future implementation steps will include further study of potential brackish groundwater opportunities. Exploration of brackish groundwater desalination for the Water Forward process was a recommendation of the 2014 Task Force.

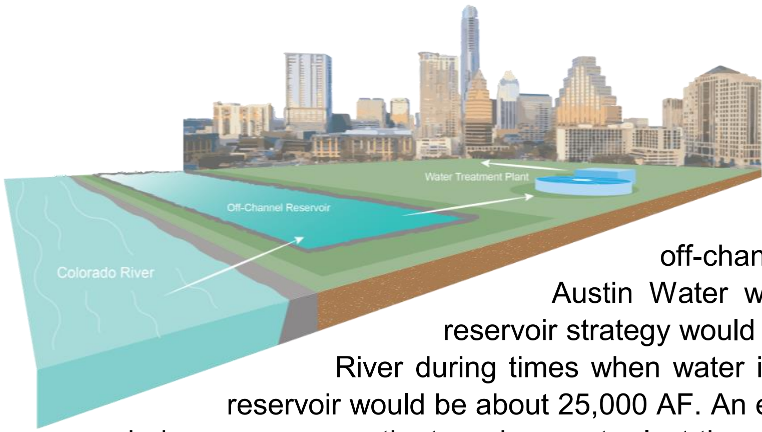
9.1.3.3 Indirect Potable Reuse through Lady Bird Lake – S5(a)

Indirect potable reuse (IPR) is recommended in Water Forward as an emergency strategy to be used infrequently during only the most severe drought situations. During deep drought periods, when combined storage of the Highland Lakes is lower than at any point in the historical period of record, IPR would be an emergency supply to meet potable water demands. This option would convey highly treated reclaimed water from one treatment train at South Austin Regional WWTP to Lady Bird Lake through a reclaimed water transmission main and subsequently divert this water through a new intake pump and piping system downstream of Tom Miller Dam to be conveyed to Ullrich WTP. This concept could utilize a reclaimed main from South Austin Regional WWTP to Lady Bird Lake that is already included in the Reclaimed System Master Plan. This approach would supplement water releases from Lakes Buchanan and Travis to extend water supplies during severe drought only. This option is a drought strategy that would be recommended for implementation only in the event of 400,000 AF of combined storage or less in Lakes Buchanan and Travis which is after the lakes have dropped below emergency and crisis levels. This option would be utilized for the shortest possible time to meet urgent supply needs. Should this option be required to be utilized in a deep drought emergency, Austin Water would perform outreach to educate and notify the public about the use of the strategy, develop robust standards to guide operations for the period when the strategy is in use, perform monitoring to ensure drinking water quality standards are met, and monitor water quality in Lady Bird Lake.



9.1.3.4 Capture Local Inflows to Lady Bird Lake – S5(b)

As the IPR strategy would only be used on an infrequent basis during severe drought conditions, the intake and pumping components could be used on a more frequent basis to capture spring flows to Lady Bird Lake when available. Lady Bird Lake inflows would be conveyed to Ullrich WTP for treatment and distribution. This strategy would allow for the capture of available spring flows, including flows from Barton Springs that flow into Lady Bird Lake, and other stormwater flows when they are not needed downstream for environmental flow maintenance or for downstream senior water rights. The average annual yield for the Capture Local Inflows to Lady Bird Lake strategy is estimated to be approximately 3,000 AFY. Water availability for the Capture Local Inflow to Lady Bird Lake option would be intermittent and seasonal, with availability more likely in the months of November through February when downstream agricultural irrigation operations are offline and environmental flow requirements are the lowest for the year.



9.1.3.5 New Off-Channel Reservoir with Lake Evaporation Suppression – S7

This strategy is recommended for the 2070 planning horizon. This strategy would involve the construction of a new off-channel reservoir in the Austin region that Austin Water would own and operate. The off-channel reservoir strategy would likely use source water from the Colorado River during times when water is available. The approximate size of this reservoir would be about 25,000 AF. An evaporation suppressant would be applied during summer months to reduce water lost through evaporation. The off-channel reservoir could also be used conjunctively with ASR, allowing further storage and evaporation management opportunities.

9.1.4 Water Forward Recommendations to Continue Core Colorado River Supplies

The Colorado River and Highland Lakes system will continue to be Austin's core supply in the future. As Austin's core supply, the City will continue to work with its regional partners to protect and enhance the Colorado River and Highland Lakes system supply. Planned actions to enhance supply include:

- Continued participation in the Lower Colorado River Authority/City of Austin Water Partnership
- Continue to engage on potential water supply development in the basin, which may include regional partnerships as a way to implement supply or demand management options
- Continued communication and information sharing with other entities in the basin
- Continued participation in Lower Colorado River Authority's Water Management Plan update processes
- Continued participation in the Texas Water Development Board-administered Regional Water Planning process
- Continued leadership and participation in Imagine Austin's Sustainably Manage Our Water Resources priority program, co-led by Austin Water and Watershed Protection Department
- Austin Water and Austin's Watershed Protection Department will continue efforts to look for synergistic opportunities
- Broaden our understanding of basin-wide issues, including both upstream and downstream issues. Explore opportunities for Austin Water to proactively protect its water supply watersheds through tools like land conservation and other potential measures.
- Continued involvement in activities, monitoring, and other efforts related to water quality analysis and protection
- Share information and work with others to study potential future climate change impacts

- Continued participation in Water Utility Climate Alliance

Best Management Practices

- *Require or incentivize government-recognized energy and water efficiency-labeled residential and commercial fixture (included in baseline in portfolio evaluation)*
- *Incentivize or require toilet, urinal, and bathroom faucet aerator efficiencies (included in baseline in portfolio evaluation)evaluation*
- *Implement the "Lake Austin Operations" option as defined in Water Forward screening process. This option would be implemented during drought periods.*
- *In alignment with ongoing efforts, add municipal as a potential use to existing City of Austin steam electric water rights*

Implementation Component

- *Use water rates and fees to promote water use efficiency while maintaining affordability*
- *Customer education enhancements*
- *Social media programs and web content to promote conservation*
- *Regional partnerships could be considered when implementing water supply options*

9.1.5 Additional Water Forward Recommendations

Austin Water will continue to implement best management practices and general implementation components required for the recommended options. These best management practices and option implementation components are summarized in the sidebar.

9.1.6 Water Forward Task Force Continuation

Water Forward recommends continuing the Water Forward Task Force on a quarterly basis to support the implementation process. Austin Water plans to lead the implementation and adaptive management phase and work with the Task Force during the implementation process. One component of the recommendation to continue the Water Forward Task Force is to have an Austin Water-led review of Ex-Officio membership on the Task Force and make adjustments to enhance the implementation process. Currently, the Ex-Officio members are made up of representatives from various City departments, but membership could include alternate City departments or additional community representatives in the future.

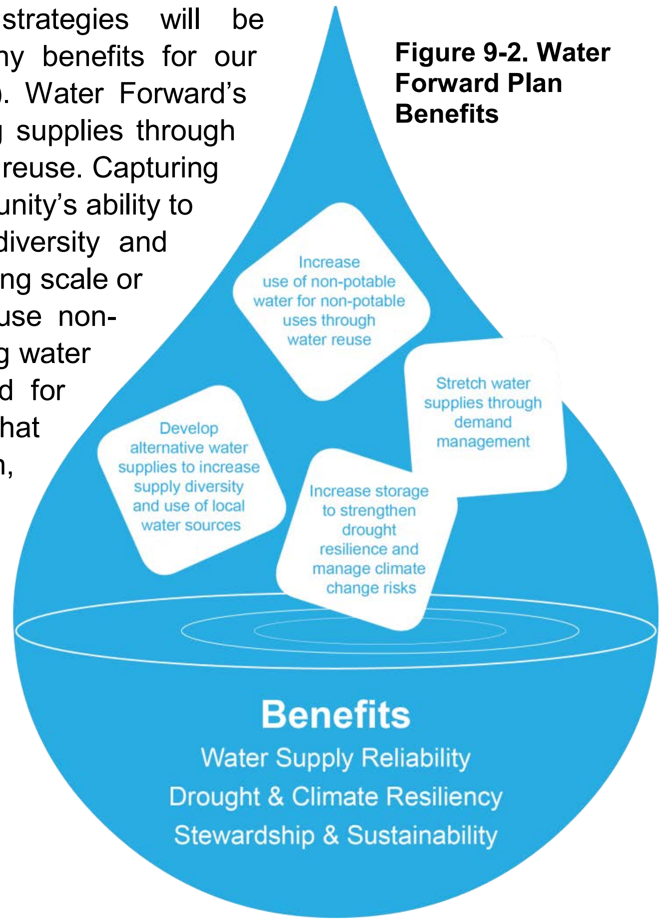
9.1.7 Other Options and Potential Future Strategies

Other options that progressed through screening but were not included in Hybrid 1 could be considered at a future point, as the plan is reevaluated on a five-year cycle. Options include community-scale rainwater harvesting, direct potable reuse, additional LCRA supply, and import options like seawater desalination or conventional groundwater.

9.2 Water Forward Plan Benefits

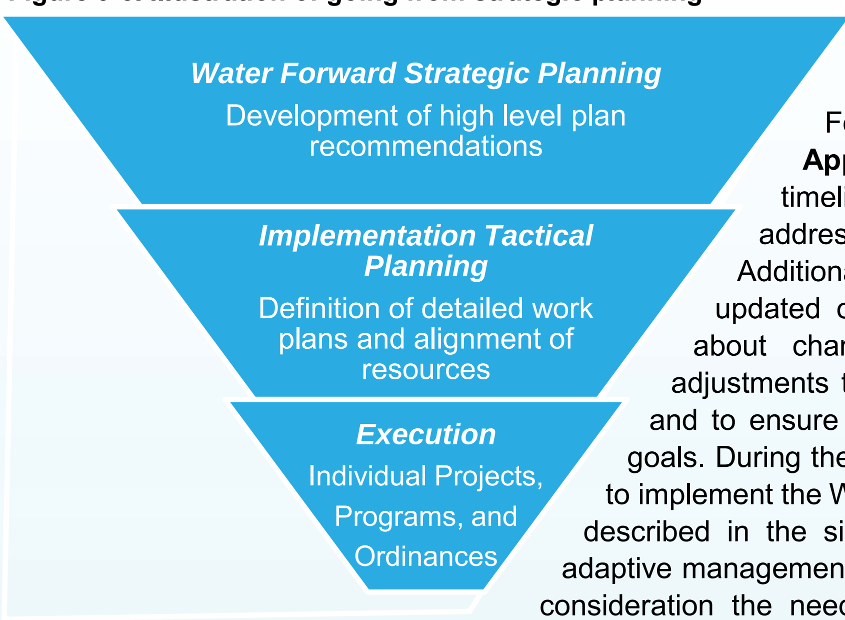
Implementation of recommended Water Forward strategies will be transformative for the City of Austin and provide many benefits for our community (see **Figure 9-2.** Water Forward Plan Benefits). Water Forward's recommended strategies will help Austin stretch existing supplies through water use reductions, more efficient water use, and water reuse. Capturing and reusing water at the point of use increases our community's ability to access all local water sources and adds to supply diversity and resiliency. Expanding reuse supplies, whether at the building scale or from the City's reclaimed water system, allows us to use non-drinking water to meet demands that don't require drinking water quality. This "fit for purpose" approach offsets demand for drinking water supplies while providing a source of supply that is less affected by changes in climate. In addition, increasing water supply reserves through Aquifer Storage and Recovery will help to provide water to the City through the longer periods of drought that we may experience in the future. By diversifying Austin's water supply and demand management portfolio, Water Forward increases the City's ability to maintain a reliable supply for the next 100 years.

Figure 9-2. Water Forward Plan Benefits



9.3 Water Forward Implementation and Adaptive Management Plan

Figure 9-3. Illustration of going from strategic planning-



Austin Water plans to begin the implementation process using an adaptive management approach immediately after City Council approval of the Water Forward plan. The Water Forward adaptive management plan (see **Appendix M**) will guide implementation timelines with the flexibility to change to address possible uncertainties in the future. Additionally, the Water Forward plan will be updated on a five- year cycle, using new data about changing conditions to inform potential adjustments to the planned implementation strategy and to ensure that we are on a path to meeting our goals. During the next five years, Austin Water will work to implement the Water Forward plan by taking the actions described in the sidebar on the next page. The current adaptive management plan lays out a timeline that takes into consideration the need to "ramp up" demand management options sooner, as they take time to realize their full benefits; time for public outreach and community engagement; time for engineering, field testing, and construction; processes for adjusting strategies should one or more options not perform as expected; and the possibility that in the longer-term, options not included in the Hybrid 1 Portfolio might become more feasible and beneficial for implementation. The exact timing of implementation will be based on several factors, such as potential uncertainty related to action step duration, the need for sequential actions, and potential resource and budget constraints of the utility, but the Water Forward adaptive management plan will allow implementation adjustments to account for these uncertainties and keep the plan on track.

Major Water Forward Implementation Actions in the Next 5 Years

Ordinances (new or changes existing)

- *Alternative water ordinance for new larger commercial and multifamily development*
- *Dual plumbing ordinance for new larger commercial and multifamily development*
- *Expand current reclaimed water system connection requirements*
- *Ordinance to require submittal of water use information for new development*
- *Monitor existing ordinances related to air conditioning condensate reuse and cooling tower and steam boiler efficiency*

Incentives

- *Expand alternative water incentive program*
- *Expand landscape incentive program*
- *Expand irrigation efficiency incentive program*

Projects and Programs

- *Study and begin design, construction, and testing of an Aquifer Storage and Recovery pilot*
- *Implement Advanced Metering Infrastructure*
- *Enhance utility water loss reduction program*
- *Expand the centralized reclaimed water system*
- *Explore community-scale decentralized reclaimed water options*
- *Refinement of Indirect Potable Reuse strategy*
- *Refinement of Capture Lady Bird Lake Inflows strategy*
- *Begin preliminary analyses to support five-year Water Forward plan update*

9.3.1 Costs

The planning-level estimated costs to implement the recommended options through the 2040 planning horizon are presented in **Table 9-3**, and further detail can be found in **Appendix J – Options Characterization Sheets**. The estimated capital and operations and maintenance (O&M) costs presented reflect community costs, which include costs to be paid by Austin Water and its ratepayers, as well as costs to developers and program participants, with potential cost offsets though utility incentives. **Table 9-3** is organized into three categories, reflecting current utility strategic initiatives in the capital plan, new utility strategies, and developer/program participant-owned strategies with potential cost offsets through utility incentives.

Table 9-3. Estimated Planning-Level Community Cost Summary for Water Forward Recommended Strategies through 2040 (in current dollars, not escalated)

Water Forward Strategies	2019-2040 Est. Cumulative Capital Cost ($M)	2019-2040 Est. Cumulative O&M Cost ($M)	2020 Yield (AFY)	2040 Yield (AFY)
Strategies that are Currently Strategic Initiatives in AW's Capital Improvement Plan (to 2040 Horizon)				

Water Forward Strategies	2019-2040 Est. Cumulative Capital Cost ($M)	2019-2040 Est. Cumulative O&M Cost ($M)	2020 Yield (AFY)	2040 Yield (AFY)
Advanced Metering Infrastructure (AMI)	$79.9	$21.0	600	3,880
Water Loss Control	$313.6	$38.5	3,110	9,330
Direct Non-Potable Reuse - Centralized Reclaimed Water	$215.4	$46.2	0	4,150
Aquifer Storage and Recovery Pilot	$4.8	$ -	NA	NA
Sub-Total:	$613.6	$105.8	3,700	17,360
Average Annual Cost Through 2040:	$27.9	$4.8		
New Strategies				
Benchmarking	$ -	$5.4	0	5,950
Landscape Transformation Ordinance	$ -	$2.9	0	3,040
Landscape Transformation Incentives*	$ -	$1.6	0	320
Irrigation Efficiency Incentives*	$ -	$1.6	40	210
Full-Scale Aquifer Storage and Recovery	$362.9	$57.2	0	60,000
Brackish Groundwater Desalination	Strategy to be implemented beyond 2040		0	0
Indirect Potable Reuse (IPR) through Lady Bird Lake	$34.9	O&M costs included as part of Capture Local Inflows in LBL (below)	0	11,000
Capture Local Inflows to Lady Bird Lake (LBL)	Capital costs included as part of IPR (above)	$1.9	0	3,000
Off Channel Reservoir	Strategy to be implemented beyond 2040		0	0
Distributed Wastewater Reuse	$18.1	$19.4	0	3,150
Sewer Mining	$13.3	$12.6	0	1,000
Sub-Total*:	$429.1	$102.7	40	87,670
Average Annual Cost Through 2040:	$19.5	$4.7		
Developer/Program Participant-Owned Strategies with Potential Cost Offsets Through Utility Incentives				
CII Ordinances	$4.0	$1.7	1,060	1,060
Lot Scale Stormwater Harvesting	$16.2	$4.8	0	330
Lot Scale Rainwater Harvesting	$31.7	$13.4	0	1,550
Lot Scale Graywater Harvesting	$111.6	$97.6	0	2,130
Lot Scale Wastewater Reuse	$74.5	$80.7	0	1,320
AC Condensate Reuse	$34.4	$ -	100	1,080
Community Stormwater Harvesting	$1.7	$0.7	0	160
Sub-Total:	$274.1	$198.9	1,160	7,630
Average Annual Cost Through 2040:	$12.5	$9.0		
Community Cost Total Through 2040*:	$1,316.8	$407.3		
Average Annual Community Cost Through 2040*:	$59.9	$18.5		

*Cost estimates do not include costs for incentives. Incentive amounts will be determined as part of the implementation phase. **Note:** Some option costs may vary from costs presented in Appendix J due to further refinement during portfolio evaluation. These planning-level cost estimates are subject to change pending further study and analysis.

Cost and affordability were key community values communicated to the project team throughout the public input process for Water Forward. To reflect cost and affordability in the development of the plan recommendations, several of the sub-objectives used to evaluate strategies for recommendation were based on cost-effectiveness and the ability to secure external funding for implementation. The recommended Hybrid 1 portfolio contains several conservation and reuse strategies, which help in stretching our existing supplies through delaying the cost of paying for water under Austin's current municipal water supply contract or purchasing additional supply that would be needed every year. As our community will need additional supplies during future droughts, planning today allows the utility to leverage advantageous funding mechanisms for projects and pace out infrastructure investment over time to mitigate potential rate impacts.

The cost of implementing the recommended strategies could be funded through, among other methods, Austin Water revenues, low-interest bonds or other outside funding, development costs, or shared community investments. In some cases, Austin Water investments could be combined with investments from the community, as in rebates and other incentive programs. Austin Water will work to determine what funding and resource requirements are most suitable to consider for implementing plan strategies and programs. This will include, among other things, evaluation of the Texas Water Development Board's State Water Implementation Fund for Texas loan program and other financing and funding mechanisms to minimize ratepayer costs.

The Water Forward plan is a high-level strategic plan intended to provide a roadmap to guide development of future programs, projects, and ordinances. More detailed cost estimates and funding approaches for each recommended strategy will be developed in the implementation phase and will be subject to future Council action as required.

9.3.2 Metrics

Various metrics will likely be used to track Austin Water's progress at implementing the Water Forward plan. Additionally, the Water Forward plan includes a recommendation that the Water Forward Task Force meet on a quarterly basis after plan approval to support and monitor plan implementation efforts. Potential metrics to monitor implementation and the need for plan adjustments are listed below.

- Population and Employment, Development Trends, and Demands: Are they tracking with the IWRP projections?

Table 9-4. Average Weather Projections of Population, Demands, and GPCD

Planning Horizon	Population	Potable and Non-Potable Demand (AFY)	Potable and Non-Potable GPCD	Potable Demand (AFY)	Potable GPCD
2020	1,101,600	145,000	117	141,000	117
2040	1,577,800	183,000	103	157,000	94
2070	2,314,800	264,000	101	189,000	83
2115	3,977,400	419,000	93	288,000	65

- Supplies: What is the ratio of supply capacity to demand?
- Project Implementation:
  - Progression of projects and programs compared to estimated project milestones (see **Appendix M** for more detailed information on planned action steps).
  - Estimated savings from implemented demand management options.

Table 9-5. Preliminary Estimated savings from recommended demand management options (Subject to Change pending further detailed analysis to be performed in the implementation phase)

Demand Management Strategy	2025 Water Savings Estimate (AF/Year)	2040 Water Yield Estimate (AF/Year)
Advanced Metering Infrastructure (AMI)	600	3,880
Utility-Side Water Loss Control	4,090	9,330
CII Ordinances (existing ordinance)	1,060	1,060
Benchmarking	0	5.950
Landscape Transformation Ordinance	0	3,040
Landscape Transformation Incentive	80	320
Alternative Water Ordinance	210	1,620
Alternative Water Incentive	500	3,860
AC Condensate Reuse (existing ordinance)	350	1,080
Irrigation Efficiency Incentive	80	200

Note: Estimates subject to change dependent on many factors including growth rates, development trends, specific ordinance and program design, regulatory and permitting considerations, etc.

- Estimated yield from implemented supply options.

Table 9-6. Preliminary Estimated yield from recommended supply options (Subject to Change pending further detailed analysis to be performed in the implementation phase)

Supply Strategy	2025 Water Yield Estimate (AF/Year)	2040 Water Yield Estimate (AF/Year)
Centralized Reclaimed System (Direct Non-Potable Reuse)	1,110	12,000
Community-Scale Distributed Wastewater Reuse	10	3,150
Community-Scale Sewer Mining	10	1,000
Aquifer Storage and Recovery	0	60,000
Indirect Potable Reuse (IPR) through Lady Bird Lake with Capture Lady Bird Lake Inflows	0	11,000
New Off-Channel Reservoir and Brackish Groundwater Desalination	0	0

Note: Estimates subject to change dependent on many factors including growth rates, development trends, specific ordinance and program design, regulatory and permitting considerations, etc.

With hard work and community support, implementation of Water Forward will create a more sustainable, reliable water supply for Austin for the next 100 years and beyond.

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