School of Sustainability
Arizona State University

CITY OF Goodyear

The City of Goodyear: Drought-Proofing the Future?

Students

Makenna Welsch

School of Sustainability, BS

Sean McElroy

School of Sustainability, BSP

Dylan Bingham

New College of Interdisciplinary Studies, MA

ASU Faculty and Advisors

Dr. Nalini Chhetri

Clinical Associate Professor & Sr. Sustainability Scientist

Mark Holmes

Water Resources Manager
City of Goodyear

Anne Reichman

Program Manager
Sustainable Cities Network

DECEMBER 2017

TABLE OF CONTENTS

Executive Summary

This document is the product of collaboration between the City of Goodyear and the School of Sustainability at Arizona State University. The main purpose of this project was to assist the city's Water Manager Mark Holmes analyze the circumstances that would help Goodyear become "drought-proof." Our team was asked to review the relationships between variable precipitation and Colorado River shortages with Goodyear's current policies and strategies regarding their water portfolio and future growth.

While the City of Goodyear is aiming for a build-out population of approximately 760,000 by 2085, as the current rate of groundwater extraction stands, consumer demand will exceed the allotted 13,191 acre feet per year between 2020 and 2025. This means that the city will have little other choice than to pursue increasingly costly importation projects. Goodyear is currently negotiating direct access to water from the Central Arizona Project canal, however as reservoirs empty and the flow of the Colorado River decreases, this option will not be a long-term solution.

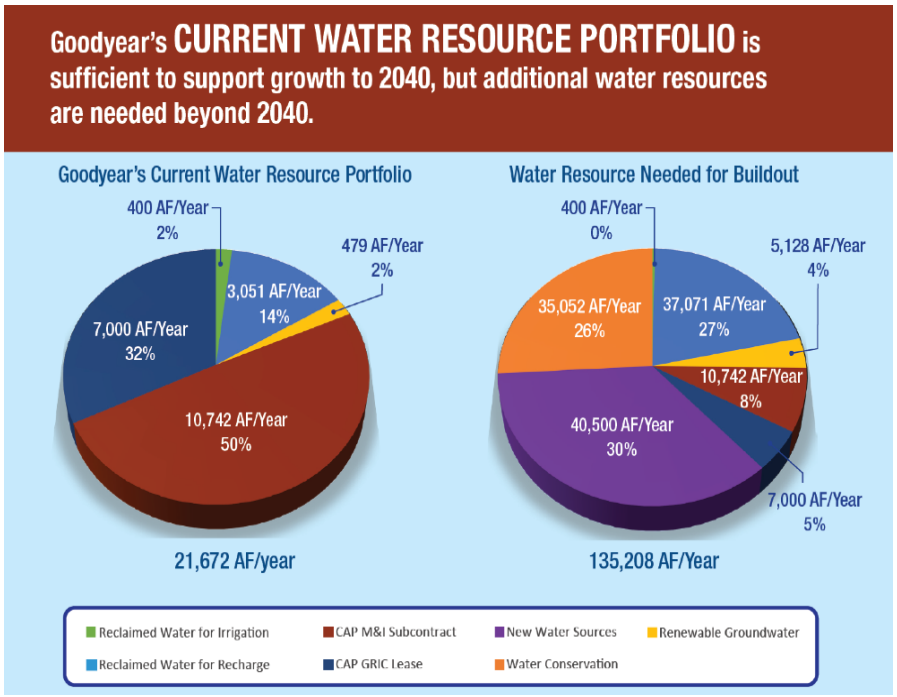


Figure 1: Goodyear's Current Water Budget & Build-Out Water Budget

An additional 40,500 acre feet of water will be needed

This report offers a conceptualization of the water challenges – primarily in terms of drought and groundwater overdraft – facing Goodyear in the short- and long-term. While these are complex phenomena, Goodyear has a unique opportunity to encourage drought resiliency throughout its community by encouraging reductions in consumption, implementing more efficient water-use strategies, and securing more water resources.

This report also offers an analysis of Goodyear's current conservation policies and its 2008 Curtailment Plan. This analysis encourages cooperative and inclusive decision-making between stakeholders, upholding the mentality that these complex problems cannot be solved by a single institution, organization, or city alone. Despite an updated Curtailment Plan being released in July of 2018, we briefly explore its significance in times of shortfall and measures that may be required if voluntary conservation falls short.

We will explore conservation recommendations to reduce residential water use, based on methods used by comparative cities within Arizona and throughout the Southwest. These recommendations include incentivizing pool covers and conveyor car washes, an increased role for homeowner associations, and smart-growth strategies based on green building techniques.

The final section will introduce our Conservation Implementation Plan. This plan will include five phases over a ten-year period in order to gradually introduce conservation and sustainable behavior. Our findings will be based on relevant literature, expert interviews, and workshops with the SOS 594 class. Lastly, we introduce the STAR Communities Rating System, which provides specific goals and actions to become a sustainable community.

Introduction

At a current population of almost 80,000, the City of Goodyear is expected to reach a build-out population of about 760,000 towards the end of this century. The city has already adopted policies for banking reclaimed water, however approximately 40,000 acre feet per year from new water sources will be needed to meet demand by 2040. Our objectives for this report include exploring water security and drought preparedness for the City of Goodyear, fostering a paradigm shift for community behavior, and encouraging the establishment of overarching sustainability goals. This will be accomplished through (1) conceptualizing drought and water scarcity, (2) analyzing Goodyear's current water use and future water requirements, (3) comparing effective drought-management strategies from similar Arizona cities as well as cities throughout the Southwest, and (4) preparing residential reduction recommendations that will include specific suggestions and an implementation strategy based on these findings

Water and Community Resilience

Contextualizing Drought and Water Scarcity

There are two main fronts from which water scarcity significantly affects Goodyear: drought and groundwater overdraft. Drought extends throughout the entire Colorado River basin, which is comprised of seven states: Wyoming, Colorado, New Mexico, Utah, Arizona, Nevada, and California (Arizona Department of Water Resources, 2016; National Research Council, 2007, Hirt, et al., 2008). Temperatures throughout this region have been increasing over the last 100-years (Arizona is currently in a 22-year megadrought [NASA], 2015]) and many future models predict continued warming (NRC, 2007). Consequently, rainfall will become more variable, snowpack will decrease, snowmelt will occur earlier in the year, and evaporation will increase (NRC, 2007). All of

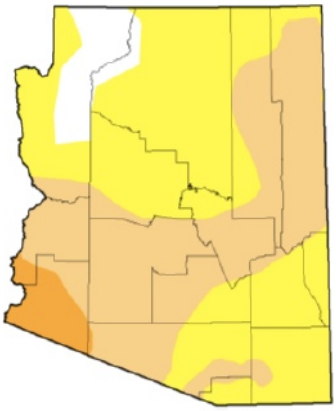
these factors will reduce the flow of the Colorado River, thus worsening the "severity, frequency, and duration of future droughts" (NRC, 2007).

The Colorado River was allocated between these seven states in a 1922 Compact; the lower basin states of Arizona, California, and Nevada were designated 7.5 million acre-feet of water, of which Arizona receives 2.8 million acre-feet (Hirt, et al., 2008). According to the National Research Council (2007), this Compact was based on above average estimates of precipitation, which created an over-allocation of the Colorado River. As it stands, the Colorado River is flowing at its lowest rate since the 1922 Compact, and with Lake Powell and Lake Mead halfway empty, "experts predict that neither is likely to be full again in our lifetimes" (Hirt, et al., 2008). As long-term drought and increasing demand stress the Colorado River, this dependency is even further problematic due to the policies that will be implemented when shortages occur (Hirt, et al., 2008). Due to Arizona's junior water rights, the state will be among one of the first to lose its allocation; for example, California will receive its *entire* allocation before Arizona receives any of its own (Hirt, et al., 2008).

The Colorado River basin extends over seven U.S. states and parts of northwestern Mexico.

For a short-term perspective, in 2016, the El Niño weather pattern (characterized by warming weather patterns) did not supply the predicted rainfall and so Lake Mead's waters remain near the first shortage trigger level (AZDWR, 2016).

Further, in 2016, both snowfall and rainfall across the state fell well-below normal levels, putting Arizona in an increasingly severe drought (AZDWR, 2016). For example, according to the Arizona Department of Water Resources (ADWR), there are 25 basins throughout the state and as of the end of 2016, "eight remained at the same level, six decreased, and 11 increased in drought severity" (AZDWR, 2016) (see figure 1).



Level	Description	Percentile	Color
	No Drought	>30	
D0	Abnormally Dry	21-30	
D1	Moderate	11-20	
D2	Severe	6-10	
D3	Extreme	3-5	
D4	Exceptional	0-2	

Figure 2: Short-Term Drought Status (Sept. 27, 2016) (AZDWR, 2016)

Figure 3 depicts a long-term perspective, wherein the prevalence of drought also grew (AZDWR, 2016). According to the ADWR, in 2016, there was no improvement throughout any of the watersheds "and three … that were not in drought became abnormally dry" (AZDWR, 2016).

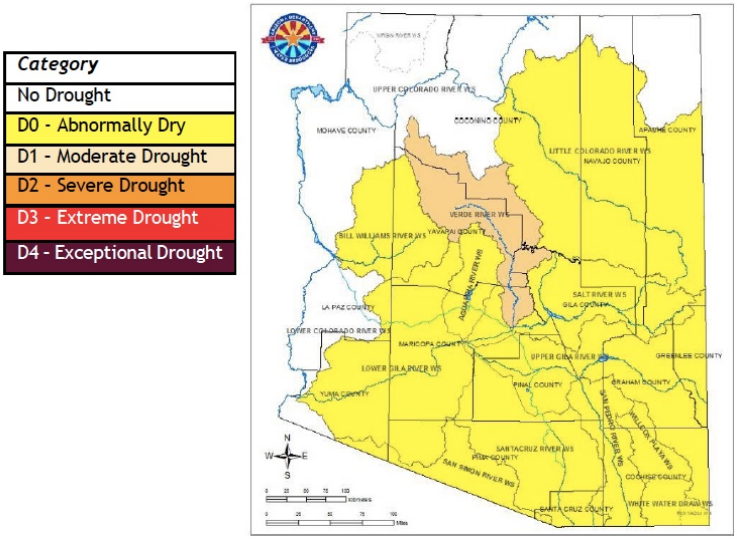


Figure 3: Long-Term Drought Status (October 2016) (AZDWR, 2016)

Population throughout these basin states has dramatically increased over the previous 30 years - 45 percent for Arizona alone between 1990 and 2004 (Larson, et al., 2009). With population growth and expanding development efforts, the Colorado River is being put under increasing strain that will require “increasingly costly, controversial, and unavoidable trade-off choices” (NRC, 2007).

Attempts to implement technology and conservation efforts (through water reclamation, desalination, pricing structures, and weather modification) are important in the short-term in order to prepare for shortages (NRC, 2007; Hirt, et al., 2008; Larson, et al., 2009). However, they are not the end-all, be-all measures that cities and states should rely upon in the long-term, especially as demand continues to rise. Rather, transparent and open dialogue and collaboration between stakeholders needs to be encouraged (NRC, 2007).

Understanding the challenges of water security should be extended to the communities in these Colorado River basin states and should hold significance for urban planners, architects, homebuilders, community organizations (e.g. homeowner associations), key decision-makers, and governments (NRC, 2007). Many drought preparedness policies are fragmented throughout these seven states, without regional cohesion and basin-wide evaluation, there are limitations to how we understand the effects of drought and water scarcity between states (NRC, 2007). Therefore, it would also be beneficial to have a regional alliance consisting of states themselves, regional agencies, federal agencies, universities or a combination of these to evaluate critical issues such as population growth, future water demand, ecological impacts, and urban water policies (NRC, 2007). It is important for Goodyear to explore local alliances with other cities facing similar challenges because with growing water scarcity and increasing costs to access new water supplies, this challenge will not be limited to one city or region.

Groundwater Overdraft

An additional layer to the water scarcity challenge facing Goodyear involves groundwater overdraft, where water is taken from an aquifer faster than it is being replenished (Hirt, et al., 2008; Larson, et al., 2009). Traditionally, the drivers of groundwater overdraft stem from population growth and economic development, which strains local water supply and requires more expensive importation projects in order to enable more development, creating "a self-perpetuating cycle of … growth, driving a competitive, acquisitive water policy" (Hirt, et al., 2008). The Groundwater Management Act of 1980 was designed to end groundwater overdraft by 2025, however strategies to accomplish this have been inadequate to avert a future crisis and many of the Act's principles have been eroded by loopholes, amendments, consumer resistance, and ineffective enforcement (Hirt, et al., 2008; Larson, et al., 2009).

Many policies that are intent on reducing groundwater use focus on the supply-side through importing water, innovative technology, and purchasing new water rights rather than on the demand- or consumer-side (Hirt, et al., 2008; Larson, et al., 2009). However, an over-reliance on slowly-replenished groundwater will come with more expensive water pumping and well drilling costs and a lower quality of water that requires expensive treatment (Hirt, et al., 2008; Larson, et al., 2009).

Focusing on supply-side policies is problematic because it focuses on principles of augmentation, where water is simply moved from one place to another, under the presumption that overdraft will end, as well as the hope that surface water will remain constant or increase, and that population growth will level-off (Hirt, et al., 2008; Larson, et al., 2009). This perspective overlooks water as a finite resource, where the absolute amount is never enlarged, it is merely "made available in certain places, with less available in others" (Hirt, et al., 2008). One suggestion to overcome this cycle, at least in

the short-term, is to start addressing the demand-side of water management by improving water-use efficiency through targeting water users and creating a lifestyle of conservation. This would entail implementing stronger conservation measures and incentives as well as growth management policies (Hirt, et al., 2008; Larson, et al., 2009).

Lastly, addressing groundwater overdraft is also critical from a regional perspective because of the impact it may have between cities. In other words, while one city may meet their water reduction targets, there is a regional disadvantage when other cities do not achieve similar targets (Larson, et al., 2009).

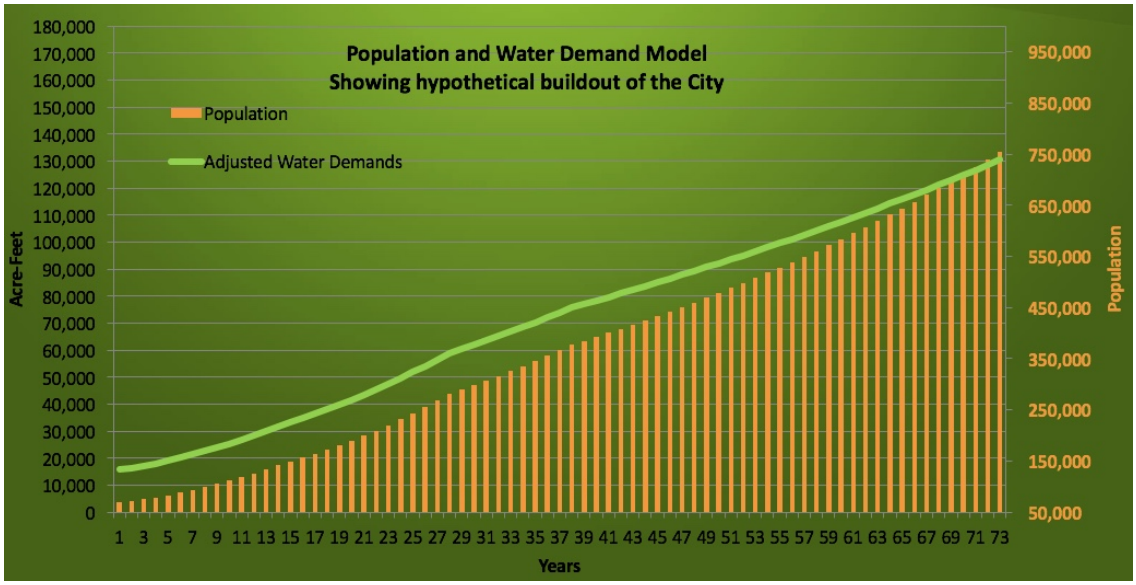


Figure 4: Goodyear's Projected Population Growth (Yellow Bars) and Water Demand (Green Line), 2012-2085

Goodyear's Current Policies and Conservation Strategies

Conservation Strategies

At a current population of 77,258 people the City of Goodyear, AZ is estimating a build-out population of approximately 760,000 people (City of Goodyear, Integrated Master Plan 2016). Although the city will not meet this build-out population until 2085, the city is required to provide an adequate volume and reliable supply of high quality potable and

non-potable water resources that meet both current and future demands (City of Goodyear, General Plan, 2016). With a significant focus on development, securing surface water sources will come at a much greater cost than implementing effective conservation measures. An occurrence of drought, as unpredictable as it might be, would imply that securing additional surface water sources such as the Salt River Project is very unlikely. Also, water from the Central Arizona Project (CAP) canal will be scarce and the difficulty of increasing the city's predetermined allotment would be immense. Therefore, especially in the short-term and in the anticipation of drought, conservation measures would be much more cost-effective because they have the potential to reduce per capita use through services and incentives targeted towards the individual users.

The current focus of the city is on reducing per capita use and reducing the spike of peak demand above the average annual daily demand. However, there is a dilemma if the city wishes to continue its development goal and reach its expected build-out population. Currently the city's wells extract water from the West Salt River Valley Groundwater Sub-Basin, but it is only allowed to extract 13,191 acre feet per year (AFY) (City of Goodyear, IWMP, 2016). The problem therefore is that the water demand in 2025 for Water Planning Area (WPA) 2 will be about 12,795 AFY (11.3 millions of gallons per day) and 4,864AFY (4.4 millions of gallons per day) in WPA 3 (City of Goodyear, IWMP, 2016). This indicates that between 2020 and 2025, the city will exceed its demand for extracting groundwater and have no other choice than to search for new sources. Between the time period of 2020 and 2025, the city has an expected set of capital costs that are a part of its Capital Improvement Plan (CIP) (City of Goodyear, IWMP, 2016). A significant component of this plan are the charges associated with the Central Arizona Project water supply that the city is entitled to. Although the city can rely on this supply when it exceeds the amount of groundwater that it can extract, the total cost of the five year plan is $1,420,000 (City of Goodyear, IWMP, 2016). While this does not seem like a very large amount in the

broader scope, the total cost of the five year CIP project is $38,959,303 and the cost for the 10-year project is $81,111,000 (City of Goodyear, IWMP, 2016). Access to the CAP water is not a very significant cost, however that does not include the costs needed to transport the water to the city, distributing it throughout the city to all its users, and also all the other improvements that will be needed to the existing system and expansions to meet an increase in supply.

A very significant statistic that highlights the city's focus on reducing per capita use is that outdoor water use is at 60% of the total water use. This implies that the city has a unique opportunity as well as a need to reduce its residential water use in order to have a guaranteed water supply for build-out. The average residential-use of water is approximately 5.5 million gallons each day during the months of December-February, while usage spikes are at 11 million gallons each day during June-August, with a high of 13 million on some days (City of Goodyear, Reduce Your Use – Outdoor, 2017). To reduce use, one of the resources that the city offers is its website, which is easily accessible through a Google search. Current measures consist of low water use landscaping that is encouraged among users and is offered in the form of free conservation classes at the Public Works Administration building (CG, RDY – Out, 2017). The classes and the website provide residents with useful resources and suggestions for how to properly manage their outdoor water use as well as a detailed chart with landscape watering guidelines (City of Goodyear, RDY – Out, 2017).

In addition, a Water Conservation Committee was established in 2016 and serves as an advisory committee to the City Council and city staff (City of Goodyear, Water Conservation Committee, 2017). It is composed of ten Goodyear residents and three representatives of associated stakeholder groups and its objective is to study water use patterns and conservation options with an emphasis on outdoor water use (CG, WCC,

2017). In their most recent meeting, the committee members discussed the topic of "commercial landscaping" (CG, WCC, 2017). Their focus was both on developing new design standards for landscaping and providing incentive-based programs for homeowners associations for existing landscapes (CG, WCC, 2017). The committee is a very important asset and it will be an essential collaborator with the city council and homeowner associations in order to implement effective behavioral change with water-use.

Curtailment Plan and Current Policies

A Curtailment Plan is a preparedness plan developed by the city in order to effectively manage its existing water resources in the event of a drastic increase in water demand. Once demand approaches and possibly exceeds the city's water supply a status of curtailment will be announced, which means that the city will incrementally impose water-use restrictions on all water-users including the city itself (CG, WCC, 2017). The purpose of such a plan is to avoid the depletion of supply and to manage it sustainably.

The current curtailment plan available was completed in 2008 and includes conservation measures that the city has completed, such as expanding its operational efficiency through the metering of all the city's supply connections to the water distribution system, a leak detection study completed in 2007, and water audits collected at all its facilities that are held for at least 2 years (City of Goodyear, Water Conservation & Curtailment Plan, 2008). An updated version of the curtailment plan is expected to be completed by July 2018 with additional conservation recommendations.

The city's current Curtailment Plan includes two important targets for water conservation: (1) to reduce per capita daily demand by 10% by 2015 and (2) to reduce the spike of peak demand above average annual daily demand 5% by 2013 (CG, WC&CP, 2008). In

addition to the targets, there are four priorities for conservation: to reduce (1) city demand, (2) outdoor demand, and (3) indoor (residential and office) demand, and to increase (4) institutional, commercial, and industrial efficiency (CG, WC&CP, 2008). A final component of this plan is five goals for conservation which include a set of proposed actions for each goal and the year to be completed (CG, WC&CP, 2008). Although the majority of the completion dates have already passed, the proposed actions are for the most part still relevant and will likely be equally addressed in the updated version. The five goals for conservation strategies are: the city will (1) lead water conservation by example, (2) build consumer commitment to improve efficiency in all use of water, especially potable water, (3) assure that a water conservation program is fiscally sound, (4) assess water conservation technologies and recommend appropriate usage, and (5) create financial incentives that accelerate adoption of water conserving practices and technology (CG, WC&CP, 2008).

The existing curtailment status on the city's website provides four stages of water restriction based on the level of shortage (City of Goodyear, Water Curtailment Status, 2017). Water restrictions are separated into a category for both residential as well as commercial and industrial (CG, WCS, 2017).

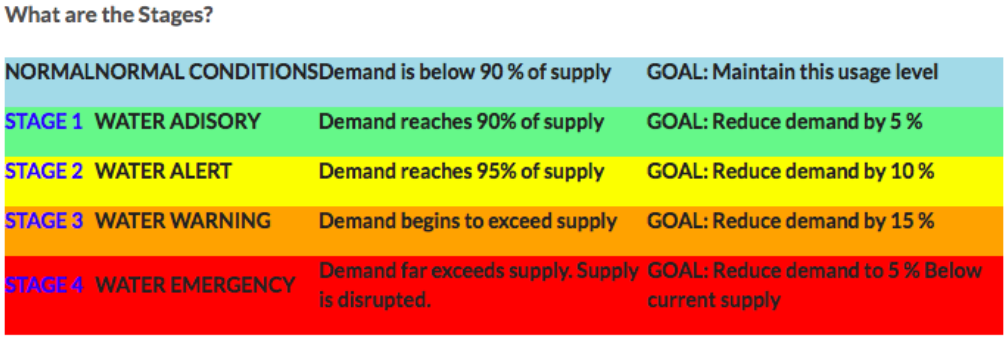


Figure 5: Water Curtailment Status (2017)

(CG, WCS, 2017)

As the image above illustrates, each stage includes a number of water restrictions that are incrementally more restrictive. Each stage implements restrictions that specify which days and times residents are allowed to water, whether or not to refill pools, washing cars, fountains, over-seeding for winter, and backwashing their pool. In the current plan, voluntary participation is encouraged until the city reaches a status of curtailment in which residents are required to reduce use, however, if they do not, there are no direct costs imposed on them. In order to target the enforceability of the water restrictions, imposing stricter fines would be a possibility. This could be done to influence consumer behavior and provide users an incentive for choosing options for conservation. Violations, citations, and a misdemeanor charge are already options to be implemented at four stages, however incremental fines could be used by the city or even HOA's before a more serious criminal charge is issued. Cooperation, particularly between the Conservation Committee and HOA's, will be useful for engaging participation in conservation programs without having to impose stricter fines.

Conservation Recommendations for Reducing Residential Water-Use

Goodyear has taken important measures towards a water conscious community. Some of these measures include free landscaping classes for residents, the creation of a water conservation committee, a water curtailment plan, and an education campaign (City of Goodyear, Water Conservation, 2017), but there is still room for improvement. Goodyear plans to keep growing and developing and so many of the conservation measures can take place during the development process, which will not only benefit the city and the environment by using less water, but will also give residents and potential residents more options when it comes to saving water.

Conservation through Homeowner Associations

Goodyear is home to many communities with HOA's and 98-percent of Goodyear's residents live in a development with an HOA (Holmes, 2017). HOA's set the regulations of each community and enforce these regulations through fines. HOA's also set the standard for front yard appearance (Holmes, 2017), which means that HOA's that require grass and lush vegetation will consume more water than those that favor xeriscaping and native plant species. Xeriscaping can be just as beautiful as a green lawn and requires less maintenance for the homeowner. Xeriscaping focuses on working with the natural microclimate of each yard, as well as planting native, drought-resistant plants, and using efficient water strategies (Arizona Department of Water Resources, Xeriscape: Landscaping with Style in the Arizona Desert, 2014). It is difficult to determine the exact number of water savings from xeriscaping because it depends on the plants chosen, size of the yard, and climate. However, a study in Nevada found that homes which converted to xeriscaping used 33-percent less water each month (Alliance for Water Efficiency, 2016). HOA's have the power to fine homeowners that do not follow regulations, which will allow them to encourage water conservation and discourage wasteful water-use.

Another way HOA's can help encourage water conservation is through the requirement of pool covers. An average 400 square foot pool can waste over 19,665 gallons of waters per year through evaporation (City of Scottsdale, Residential Water Use, 2017) but by requiring pool covers, 95-percent of this evaporation could be prevented (Shasta Pool & Spas, 2014) . Pool covers also have the added benefit of preventing children from falling into pools. To enforce their use, HOA's could perform random inspections to ensure that they are being used when the pool is not in use. Further, to help encourage the purchase of pool covers, Goodyear could offer rebates to residents. The Southern Nevada Water Authority offers residents instant rebate coupons ranging from $50 to $200 for pool covers (Southern Nevada Water Authority, 2017). Another option would be for HOA's to require

residents that want to build a pool to convert their yard to xeriscape in order to offset their water use.

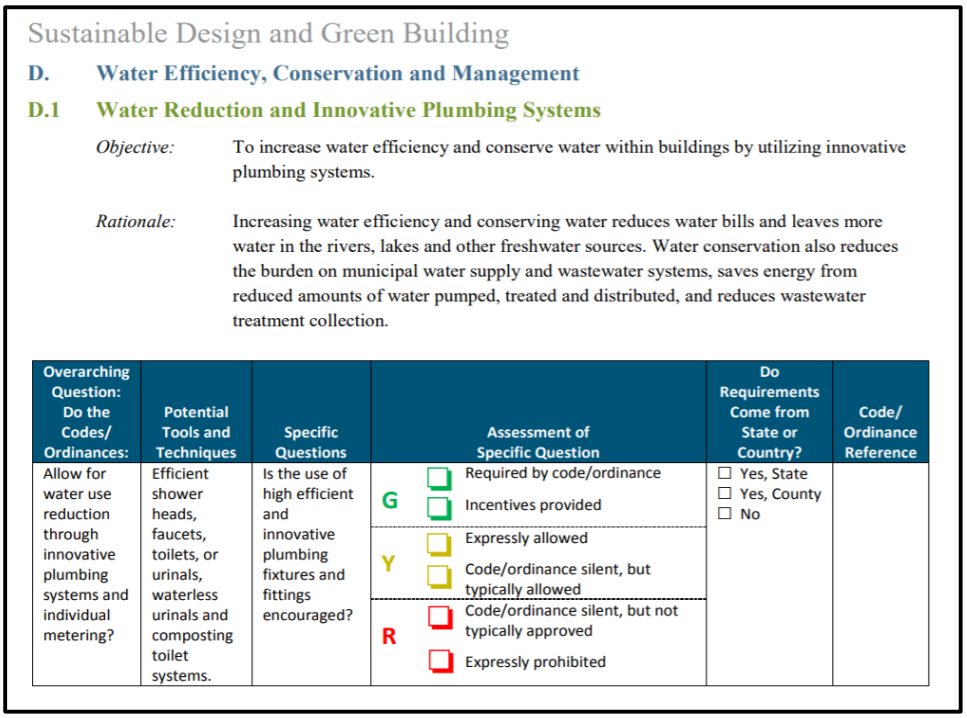
Another example of how residents could reduce their outdoor water consumption includes washing their cars at a conveyor wash. HOA's could provide residents with an unlimited car wash pass that would be included in their HOA fees, which would encourage residents to go to the carwash rather than washing their cars at home. The unlimited use of this pass could potentially be problematic and the city will need to evaluate if residents are visiting carwashes more frequently and offsetting any water savings (putting a limit on the number of uses may be a solution, if necessary). Redirecting water use to carwashes is important because not only do people use too much water when they wash it at home, but most car washes recycle at least some of the water they use and they also dispose of contaminated water correctly by treating it before sending it into the sewage system (3 Minute Express Car Wash, 2017). An example of why this is crucial for residential water use is that an average garden hose can use up to 10 gallons of water per minute, which means that a ten minute car wash at home can use up to 100 gallons of water, whereas most conveyor car washes use about 30-50 gallons of water per car (Maryland Department of the Environment, 2017).

Figure 6: Example of Xeriscaping in Arizona (Arizona Landscape Creations)

Figure 7: Example of a Pool Cover in Arizona (Solar Safe Pool Covers)

Smart Growth and High-Density Development

Goodyear is growing and expected to grow even more. With this expected growth, it is even more crucial to adopt water conservation principles early on. The type of development can play a big role in water usage. For a water-conscious community like Goodyear, "smart growth" and high-density development allow sustainable growth and water conservation. Low-density sprawl results in more impervious material which makes it difficult for runoff to percolate into the aquifers. This is especially important for Goodyear since the city depends almost completely on groundwater. A denser community means fewer pipes and fewer chances for water to leak from these pipes, which helps conserve water in the long-term (Urban Land Institute, 2005). It would also result in small yard spaces with less area to irrigate.



Sustainable Design and Green Building

D. Water Efficiency, Conservation and Management

D.1 Water Reduction and Innovative Plumbing Systems

Objective: To increase water efficiency and conserve water within buildings by utilizing innovative plumbing systems.

Rationale: Increasing water efficiency and conserving water reduces water bills and leaves more water in the rivers, lakes and other freshwater sources. Water conservation also reduces the burden on municipal water supply and wastewater systems, saves energy from reduced amounts of water pumped, treated and distributed, and reduces wastewater treatment collection.

Overarching Question: Do the Codes/ Ordinances:	Potential Tools and Techniques	Specific Questions	Assessment of Specific Question	Do Requirements Come from State or Country?	Code/ Ordinance Reference
Allow for water use reduction through innovative plumbing systems and individual metering?	Efficient shower heads, faucets, toilets, or urinals, waterless urinals and composting toilet systems.	Is the use of high efficient and innovative plumbing fixtures and fittings encouraged?	G: Required by code/ordinance; Incentives provided Y: Expressly allowed; Code/ordinance silent, but typically allowed R: Code/ordinance silent, but not typically approved; Expressly prohibited	☐ Yes, State ☐ Yes, County ☐ No	

Figure 8: Example of information presented by *Sustainable Design and Green Building Toolkit* (EPA, 2013)

The Environmental Protection Agency (EPA) created a Sustainable Design and Green Building Toolkit that helps local governments evaluate their current ordinances and

highlights how these ordinances can be changed for more sustainable “smart” growth. This assessment would allow the city to understand where their policies allow and create barriers regarding “sustainable design and green building practices” (EPA, 2006). Besides conserving more water, higher density development also reduces traffic congestion, saves money and materials for infrastructure (i.e. roads and sewage lines), increases walkability, and reduces air pollution (ULI, 2005).

The City of Goodyear could also benefit from the STAR Communities Rating System, which provides specific goals and actions to become a sustainable community. STAR focuses on compact development with human-scaled communities with diverse services, housing options, and transportation options that are easily accessible (STAR Communities, 2016). According to STAR Communities, an action that would help increase density is to “adopt regulatory strategies that permit or incentivize increased residential and employment densities” (STAR Communities, 2016).

Conservation Implementation Plan

Our recommendation for the implementation of conservation measures and ensuring sustainable resiliency is to follow five phases that will develop the best practices for stakeholder involvement and incentives. The intended aim is that these phases will be implemented over a ten-year period in order to prevent or delay the amount of groundwater that the city is allowed to extract. In addition, a couple of long term impacts for the city are water security, community behavior change and paradigm shift, drought preparedness, and establish city sustainability goals.

Preparation

Most components within the preparation phase are in terms of governance structure and resources to implement stricter conservation strategies. For example, the City of

Goodyear has developed a comprehensive water portfolio in order to identify its current water resources as well as what is needed in the future. Additionally, the city's Curtailment Plan is already in the process of being updated. Given that the city is pro-development, more restrictive conservation measures can be tailored towards new developments, which presents a unique opportunity for the city to address the issue. When designing ordinances and regulations, context is crucial. Policymakers will need to understand consumer water behavior because, while many of our suggested strategies have worked in other cities, they may not translate as effectively to Goodyear.

It will be crucial to reflect upon what further changes are needed in order to design city ordinances that provide incentives for consumers to conserve water, as well as regulations necessary for xeriscaping. This process will require coordination between influential stakeholders, including: constituents, the Water Conservation Committee, the City Council, HOA's, home developers, and landscape architects. One strategy may include interviewing home developers and landscape architects and explore what the necessary requirements are for residential developments with attractive xeriscaping. Another strategy would be to interview developers that specialize in medium and high density development. Future smart growth and a denser urban environment does not imply that the entire future population will live in apartment complexes. Rather, ideal growth would include strategically planning for multi-family and single-family units throughout the city by focusing on walkability as an incentive for denser land uses.

Capacity

The second phase includes exploring the capacity of stakeholders. Strategies to determine capacities include formulating landscape design standards for all new developments, which can be achieved through landscape irrigation audits and determining the actual irrigation system performance, as well as increasing collaboration

efforts between the Conservation Committee and HOA's in Goodyear. This alliance will require determining which HOA's are willing to pursue conservation, as well as what can be done about those that are not. Further, with most new developments being in WPA 2 and 3, the city will need to identify how many will have HOA's and how dense they will be. Lastly, we recommend a pilot study to identify which incentives for water conservation would work and what the savings and cost benefits would be. For example, a possible incentive would be to have the consumer decide whether they would prefer to have a pool with no grass or vice versa. Also, it will be important to identify the difference in effectiveness between rebates and consumers choosing between xeriscaping and a pool with the maximum turf limit.

Community Mobilization

The third phase includes identifying community vulnerabilities, spurring community engagement, and mobilizing community conservation efforts. Currently, classes on conservation measures for landscaping practices and irrigation systems are provided free of charge every two weeks. This method of consumer education can be useful, but an additional resource is to develop open houses that provide examples of an ideal drought-resistant house. An open house can be in the form of a physical house or a presentation given at the city hall or a community center. Future home buyers who wish to live in the City of Goodyear will want to live in a desirable community with attractive household designs. By providing a design that includes xeriscape landscaping as well as conservation features such as greywater systems or an example of a pool cover the city is providing homeowners with the template for a drought-resistant future. Future residents of Goodyear should want to live there because the city has a priority of being water conscious and implementing progressive policies. The city can portray itself as a leader among West Valley cities in sustainable water management by implementing conservation measures to create attractive xeriscape communities.

Another strategy for future developments that ties in with the anticipation of growth is the advertising and marketing of future developments. The Goodyear 2025 General Plan illustrates in its land use plan that residential land uses will be made up of neighborhoods and scenic neighborhoods. The scenic neighborhoods in particular are characterized as having a focus on preservation in a rural manner, however the other category of neighborhoods could be depicted as unique and diverse in addition to being drought-resistant. Neighborhoods can be advertised a having a unique character with an attractive array of native landscapes. Goodyear's neighborhoods will be different than other cities in the west valley because of their water conscious design and residents who care about the sustainable management of its water sources.

The vulnerability of a community can be expressed as a high amount of per capita water-use and a lack of proper irrigation practices. Communities that have higher per capita water rates, non-native landscaping, and pools will be much more vulnerable to water shortages and in the worst case, a drought. One method that Goodyear can use to identify vulnerabilities among current communities is by examining HOA's Declaration of Covenants, Conditions, and Restrictions (CC&Rs). For example, sometimes HOA's require residents to have grass, which is an impediment to the community's overall sustainability. HOA's with such requirements will need to be advised to adopt new CC&Rs that prioritize xeriscaping. An HOA could provide the homeowner with the choice of either a pool with xeriscape landscaping, a pool with the maximum turf limit, or complete xeriscaping.

As our conservation recommendations suggest, HOA's could choose from a variety of options such as requiring pool covers, xeriscaping to offset water use from a pool, an unlimited monthly car wash pass, or a rebate program (see Conservation

Recommendations section). An additional incentive could be to include reductions in monthly fees for residents who adopt more restrictive landscaping in a tiered reward system. For example, residents with xeriscape landscaping receive a 50-percent reduction in their monthly fees, xeriscaping with a pool is a 25-percent reduction, and a pool with the maximum turf limit is the normal rate.

Goodyear should also target communities that have larger per day per capita water consumption with a comprehensive landscape design standard. By having such a standard, the city can conduct landscaping irrigation audits in order to determine the irrigation system performance. Doing so would allow the city to locate the areas where water is used more and where it is used less, thus highlighting the areas needing more restrictive measures. This could be achieved by either focusing on the area of each respective HOA or by breaking up each WPA into proportional section.

Implementation

This section will explore methods to implement the suggestions laid out in the previous three phases. The main suggestions for implementing include building denser housing, installing xeriscaping incentives, engagement activities, and creating cooperation between the city and HOA's.

Once the city staff has interviewed qualified developers and landscape designers, the city will have an idea of the best practices that can aid in developing the most effective conservation strategies. After the city finds out which developers are willing to implement conservation components, they will be able to incorporate those systems into the new developments and if the city chooses to, implement a rebate program. This strategy would also require developers to start implementing new codes and guidelines that the City Council will need to establish. Constructing new and denser housing developments

will assure a better utilization of space, which means smaller yards and less grass. Interviewing and even hiring a landscape designer or architect would be very beneficial for the city, especially for the Water Conservation Committee. The designer or architect would be very helpful for the Committee in order to make recommendations to each respective HOA.

The Committee will advise the HOA's on the best practices for landscaping by attending HOA board meetings. Further, landscaping architects and designers will advise the city on whether HOA's and developers are following drought-resistant landscaping practices. Finding a landscape auditor is an additional benefit so that the city can properly assess which areas or HOA's in the city are not reducing their per capita use by the required amount. Further, the committee and other city staff will continue to work on community engagement through event programs such as the suggested open houses which can be advertised by either a HOA or the city. Conservation classes and additional education programs will continue to be implemented.

A particular concern of the city is the lack of a benchmark with which the city can measure itself compared to other cities. The STAR Communities Rating System is a useful resource that the city could use to compare itself to other cities that have the objective of creating sustainable communities. The Sustainable Design and Green Building Toolkit created by the EPA would also be a useful resource for the city in order to implement a framework for building a denser urban environment. Once this resource is adopted, the city can work with developers in order to evaluate and appropriately create ordinances that prioritize denser growth.

Review and Evaluation

Following implementation, the city will need to work to consistently monitor per capita use in the different areas of the city. These numbers will help determine whether consumer behavior has been curbed or if more coercive options are needed. The city will need to standardize and create measurements for success, according to their priorities.

Another method of evaluation will include selecting city staff to attend HOA meetings in order to assess their progress and make suggestions as necessary. City staff would have to continuously monitor which HOA's are adopting the recommended conservation strategies and praise or hold those accountable who are not making effective changes. The Conservation Committee and any related city staff within conservation are important assets for this phase because they are charged with analyzing and reviewing the potential savings, costs, and benefits of the conservation programs that are introduced.

If these strategies are implemented and if consumer use has not been reduced, the city will need to reevaluate whether they are reaching a point where curtailment needs to be implemented, as well as develop additional original and contextual strategies that the city could use to curb consumer behavior while still providing the amenities and services that make Goodyear an attractive place to live.

Going forward, Goodyear should also establish city sustainability goals in order to expand sustainability efforts beyond water. The STAR Communities Rating System is a useful reference for the city and could serve as a benchmark framework that the city can use to measure its own sustainability efforts as well as use other cities as comparisons.

Conclusion

The City of Goodyear is working towards a sustainable water-conscious community, but with expected growth and uncertain water supplies, steps to reduce water usage even further need to be taken. Drought and groundwater overdraft along with increasing climate change threaten cities across the Southwest, like Goodyear. Collaboration and transparency between stakeholders is necessary for solving current and future water dilemmas. A shift in people's relationship with water needs to happen to foster a community of water conservation. Starting with small changes – such as the conservation recommendations in this paper – can serve as drivers for larger change in a community. Utilizing HOA's to manage residential water use through incentives and fines and requiring developers to increase density are relatively small, obtainable advancements that can go a long way in water conservation. The Conservation Implementation Plan outlines how these recommendations, as well as others, can be successfully executed. Through thorough preparation, exploring stakeholder capacities, community involvement, implementation, and consistent evaluation, conservation strategies can thrive in the City of Goodyear.

References

Alliance for Water Efficiency. (2016). Xeriscape Water Savings. Retrieved from: http://www.allianceforwaterefficiency.org/xeriscape_water_savings.aspx.

Arizona Department of Water Resources. (2014). XERISCAPE: LANDSCAPING WITH STYLE in the ARIZONA DESERT. Retrieved from: http://www.amwua.org/landscape/landscape_principles.html.

City of Goodyear. (2016). *City of Goodyear General Plan*. Retrieved from http://www.goodyearaz.gov/home/showdocument?id=10645.

City of Goodyear. (2017). "Reduce Your Use - Outdoors". Retrieved from http://www.goodyearaz.gov/government/departments-divisions-a-z/public-works/water-conservation/watering.

City of Goodyear. (2017). "Water Conservation". Retrieved from http://www.goodyearaz.gov/government/public-works/water-services/water-conservation.

City of Goodyear. (2017). "Water Conservation Committee." Retrieved from http://www.goodyearaz.gov/government/departments-divisions-a-z/public-works/water-conservation-committe.

City of Goodyear. (2017). "Water Curtailment Status." Retrieved from http://www.goodyearaz.gov/government/departments-divisions-a-z/public-works/water-services/waterconservation/water-curtailment-status.

City of Goodyear. (2016). *City of Goodyear General Plan*. Retrieved from http://www.goodyearaz.gov/home/showdocument?id=10645.

City of Goodyear. (2016). *2016 Integrated Water Master Plan.* Retrieved from http://www.goodyearaz.gov/home/showdocument?id=16051.

City of Goodyear. (2008). *Water Conservation and Curtailment Plan*. Retrieved from http://www.goodyearaz.gov/home/showdocument?id=9426.

City of Scottsdale. (2017). "Residential Water Use". Retrieved from http://www.scottsdaleaz.gov/water/residential-water-use.

Environmental Protection Agency. (2006). Protecting Water Resources with Higher-Density Development". Retrieved from https://www.epa.gov/sites/production/files/2014-03/documents/protect_water_higher_density1.pdf.

Hirt, Paul, Annie Gustafson, and Kelli Larson. "The Mirage in the Valley of the Sun." *Environmental History*, Vol. 13, No. 3 (2008): 482-514.

Larson, Kelli L., Annie. Gustafson, and Paul W. Hirt. "Insatiable Thirst and a Finite Supply: An Assessment of Municipal Water-Conservation Policy in Greater Phoenix, Arizona, 1980-2007." *Journal of Policy History* Vol. 21, No. 2 (2009): 107-37.

Maryland Department of the Environment. Water Conservation and Washing Vehicles. Retrieved from: http://mde.maryland.gov/programs/water/waterconservation/pages/carwashing.aspx.

Megadroughts Projected for American West. National Aeronautics and Space Administration. Goddard Media Studios. February 12, 2015. Accessed November 11, 2017. https://svs.gsfc.nasa.gov/11776.

National Research Council. *Colorado River Basin Water Management: Evaluating and Adjusting to Hydroclimatic Variability*. The National Academies of Sciences. Division of Earth and Life Studies. February 01, 2007. Accessed November 10, 2017. http://dels.nas.edu/resources/static-assets/materials-based-on-reports/reports-in-brief/colorado_river_management_final.pdf.

Shasta Pools & Spas. (2014). "How to Prevent Pool Water Evaporation in Your Arizona Pool". Retrieved from http://www.shastapools.com/how-to-prevent-pool-water-evaporation-in-your-arizona-pool/.

STAR Communities. (2016). "STAR Community Rating System; Version 2.0". Retrieved from http://www.starcommunities.org/wpcontent/uploads/2016/10/STARV2_RatingSystem_Final1.pdf.

United States. Arizona Department of Water Resources. *2016 Arizona Drought Preparedness Annual Report*. Accessed November 01, 2017. http://www.azwater.gov/AzDWR/StatewidePlanning/Drought/documents/2016Report.pdf.

United States Census Bureau. (2015). *2015 Goodyear Special Census.*

Urban Land Institute. (2005). Higher Density Development. Retrieved from: http://uli.org/wp-content/uploads/ULI-Documents/HigherDensity_MythFact.ashx_.pdf.

3 Minute Express Car Wash. (2017). Frequently Asked Questions. Retrieved from: http://www.3mincarwash.com/faq/.