BAY AREA ONE WATER NETWORK

PATHS FOR EQUITABLY ADVANCING WATER CONSERVATION IN THE SAN FRANCISCO BAY AREA

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About this Report

This report is part of a series of documents developed by the Bay Area One Water Network to assess options for advancing water system sustainability, resilience and security in the San Francisco Bay Area (Bay Area). By sharing lessons learned, showcasing successes and identifying best practices, we aim to provide decision makers with tools to meet the Bay Area's future water needs.

This report presents the findings from a two-day workshop focused on equitably advancing water conservation in the Bay Area, held virtually and in San Francisco, California on June 28 – 29, 2022. At the meeting, workshop participants discussed strategies, opportunities, and challenges for advancing water conservation in ways that reduce existing or potential inequities in water access, quality, and affordability in the Bay Area. This report describes the history and current state of water conservation in the Bay Area, delineates values to guide water conservation investments, and describes key water conservation challenges and solutions. Finally, the report specifies areas of research needed to understand opportunities for equitably advancing water conservation in the Bay Area.

The Berkeley Water Center prepared this report with support from the sponsors of the Bay Area One Water Network. It reflects synthesis and interpretation of presentations and discussions from the June 2022 workshop, but is not intended to be a comprehensive assessment of the opportunities for water conservation in the Bay Area. Rather, the intent is to spur further consideration, discussion, and action.

See Appendix A for a list of workshop participants.

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EXECUTIVE SUMMARY

A San Francisco drought-tolerant garden

Image credit: Frank Farm, Flickr

Water Supply in Crisis

The San Francisco Bay Area faces a growing water crisis. In 2022, Sierra snowpack measured just 37% of the historical average, resulting in 5% allocations by the State Water Project and an 11% cutback targeted by the Hetch Hetchy Regional Water System. **Looking ahead, the outlook does not improve:** climate scientists warn that Sierra snowpack at the end of the 21st century may average only 20% of what it averaged at the end of the 20th century.

Conservation as a Solution

New solutions are urgently needed to ensure a sustainable water supply future, and **water conservation ranks among the most effective strategies**. Through conservation, communities can reduce drought impacts and accommodate growth with lower cost, energy, and environmental impact than it would take to develop new supplies. Conservation must be implemented thoughtfully, however, to avoid unintended consequences to affordability, quality of life, wastewater operations, and recycled water supply.

Image credit: Bruce Allen, Flickr

In 2022,

Sierra snowpack measured just **37%** of the historical average. Climate scientists project a further drop to **20%** by the end of this century.

Implementing Conservation Thoughtfully

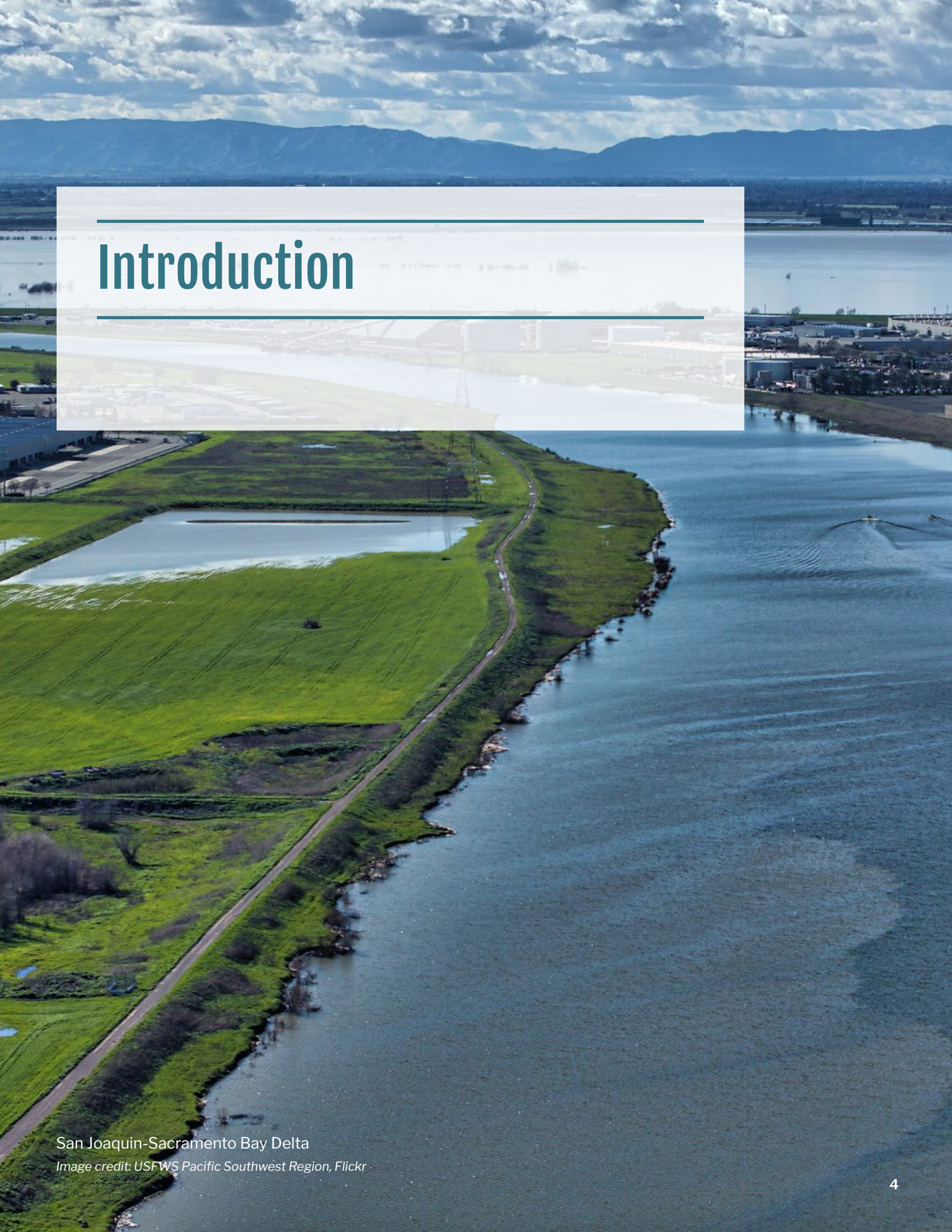
In a two-day workshop focused on equitably advancing water conservation in the Bay Area, participants discussed strategies, opportunities, and challenges building towards this goal. The following table summarizes water conservation challenges and solutions identified through the workshop and discussed in more detail in the full report. While these challenges and solutions are not intended to be a complete list, they provide key areas of focus for advancing water conservation.

CHALLENGE	SOLUTIONS
Affordability	— Reach low-income households with water bill assistance programs — Incentivize water-efficient upgrades without up-front cost burden — Address differing levels of use through budget-based water rates
Equitable Landscape Transformation	— Incentivize drought-tolerant landscaping without up-front cost burden — Provide training for "green collar" jobs to transform landscapes — Unlock co-benefits through integrated planning efforts — Prioritize water use supporting public green space
Motivation	— Develop regional vision for how to use "saved" water — Invest in behavioral change through education and outreach — Celebrate successes achieved through conservation
Compatibility with Existing Water Infrastructure	— Plan to right-size infrastructure with conservation in mind — Prioritize outdoor water conservation — Monitor wastewater influent to support data-driven adaptations — Reassess demand assumptions for drought planning — Invest in supporting drought security measures like storage

Path Forward

Through water conservation, the Bay Area can continue working towards a future in which **water supply enhances environmental and social goals, through responsible use and without sacrificing quality of life.** Advancing conservation most equitably will require **co-production of plans and goals**, including resource managers, land use planners, and marginalized communities and Tribes. It will also require **new research directions** supporting these efforts. Effective partnerships can help ensure water conservation is **integrated into broader regional planning efforts** for climate resilience, social justice, water supply and wastewater treatment, and ecological sustainability.

Introduction



San Joaquin-Sacramento Bay Delta

Image credit: USFWS Pacific Southwest Region, Flickr

Why Conserve Water?

Much of the Bay Area's water supply comes from snowmelt from the Sierra Nevada through diversions from the Bay Delta and dams on the Tuolumne and Mokelumne rivers. **Yet these water supplies are highly vulnerable to a changing climate:** year-to-year, the Bay Area's climate is predicted to get drier and more variable.[1]

In a business-as-usual scenario in the longer term, climate scientists warn that Sierra snowpack at the end of the 21st century will average only 20% of what it averaged at the end of the 20th century.[2] Less available snowmelt will heighten tensions among urban water users, agricultural and industrial water users, and the environmental and cultural requirements for water flows in rivers. Already, the State Water Board has declared that in the Spring of each year, 40% of the water flow should be left in the Tuolumne River for fish and other wildlife,[3] a proposal that has been contested by some Bay Area water agencies.[4] Using less water is one important way to reduce the demand for water from the state's rivers. For these reasons, among others, "Making Conservation a California Way of Life" is the first step of California's Water Action Plan.[5]

Even as the metropolitan Bay Area's imported water supplies are strained, the region's population is growing. By 2070, researchers estimate that the Bay Area will host 6.8 million more people and 2.2 million more homes than in 2020.[6] Despite a growing population, overall water demand in the Bay Area doesn't have to increase. In *Water for a Growing Bay Area*, SPUR and the Pacific Institute calculate that more efficient use of water can offset the water demands due to population growth, resulting in no net increase in regional water demand. This experience has been borne out by the City of San Francisco, where the population grew by 13% between 2005 and 2020 while residential water demand *dropped* by 24%.[7]

Using less water and using water more efficiently can provide multiple benefits. In addition to potentially reducing water imports and accommodating population growth without the costs and environmental impacts of developing new water supplies, using less water could also result in less energy use to treat and distribute water. For example, a 25% reduction in water use in San Francisco could produce enough electricity to power the entire BART system for more than 6 months.[8] Households using less water, and using water more efficiently, may find their water bills more affordable.[9] Water use efficiency can cut costs for both water agencies and water users: over 25 years, water conservation and efficiency efforts in Los Angeles were calculated to have saved the water agency $11 billion dollars in costs for supplying, treating, and distributing water to the population.[10] These savings were

1 Ackerly et al., "California's Fourth Climate Change Assessment: San Francisco Bay Area Summary Report."

2 Ackerly et al.; Cloern et al., "Projected Evolution of California's San Francisco Bay-Delta-River System in a Century of Climate Change."

3 California State Water Resources Control Board, "Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary."

4 San Francisco Public Utilities Commission, "2020 Urban Water Management Plan for the City and County of San Francisco Public Review Draft."

5 California Natural Resources Agency, California Department of Food and Agriculture, and California Environmental Protection Agency, "California Water Action Plan 2016 Update."

6 Feinstein and Thebo, "Water for a Growing Bay Area."

7 San Francisco Public Utilities Commission, "2020 Urban Water Management Plan for the City and County of San Francisco Public Review Draft."

8 Spang, Holguin, and Loge, "The Estimated Impact of California's Urban Water Conservation Mandate on Electricity Consumption and Greenhouse Gas Emissions"; "Energy Use."

9 Cooley, Shimabuku, and DeMyers, "Advancing Affordability Through Water Use Efficiency."

10 California Water Efficiency Partnership and Alliance for Water Use Efficiency, "Lower Water Bills: The City of Los Angeles Shows How Water Conservation and Efficient Water Rates Produce Affordable and Sustainable Use."

passed along to water users, who would have otherwise seen their water rates go up. Using less water can enable water agencies to extend the lifetime of current infrastructure, and avoid costly investments in new water supplies. Using less water for outdoor irrigation can also prevent polluted dry-season runoff, also known as "urban drool," from fouling local waterways.[11]

In the Bay Area, about 63% of the water use happens in residences, compared to 37% by commercial and industrial applications. Of the water use that happens in residences, 61% happens indoors.[12] Opportunities to use water more efficiently indoors include replacing older, less-efficient appliances with newer models that accomplish the same task (e.g., low-flow toilets), and changing water-using habits (e.g., taking shorter showers). Outside, attractive low-water landscapes, including native plants that can provide habitat for local wildlife, can replace lawns. Deep-rooted shade trees can replace non-functional turf in parks that needs to be watered daily. Fixing leaks both indoors and outdoors can also improve efficient water use. Great gains have been made over the past 30 years in improving water use efficiency both indoors and outdoors, but there is still space for improvement.

Per capita water use in the Bay Area is heterogenous and varies dramatically with income. In 2021, the average resident of wealthy Los Altos Hills used more than five times as much water as the average resident of economically disadvantaged East Palo Alto (247 gallons per day compared to 43.6 gallons per day, respectively).[13] And those are just *averages*. Some of the biggest residential water users during the irrigation season in the East Bay can use 5,000 or more gallons per day![14]

[11] Rippy et al., "Small Drains, Big Problems."
[12] Feinstein and Thebo, "Water for a Growing Bay Area."
[13] BAWSCA, "Per Capita Water Use."
[14] Rogers, "Some Bay Area Residents Are Using 30 to 40 Times as Much Water as Their Neighbors. Here's Who They Are."

A Thoughtful Path Forward

Starting from the baseline assumption that using less water in the Bay Area is beneficial and desirable for myriad reasons, a thoughtful approach is needed to determine how we go about advancing water conservation and improving water use efficiency. In this report, **conservation** refers to using less water overall, and **water-use efficiency** means using less water to do the same task. **Without thoughtful planning, using less water could have a range of adverse impacts,** including unintended consequences to wastewater systems operations, loss of urban green space and exacerbation of the urban heat island effect, inability to meet recycled water commitments, and reduced water affordability for the most vulnerable households.

Policies and technologies to promote water savings can also be leveraged to advance wider societal goals of social equity, climate resilience, and ecological health. By implementing inclusive decision-making processes, determining priority uses for the "saved" water, ensuring equitable distribution of funding opportunities, and fairly enforcing water use restrictions, we can build communities that are more equitable, resilient and sustainable while also conserving water.

Water conservation is generally cheaper compared to other water supply options, and can potentially provide more co-benefits, so there is a growing consensus among policy-makers, elected officials, and water managers that improving water use efficiency should be a top priority. However, the biggest urban water users tend to be the wealthiest households, so water conservation programs that aim to save the most water for the least amount of money have traditionally targeted these big water users. Yet this strategy can exacerbate social inequities by directing more public funding towards the wealthiest communities. Going forward, **key political decisions will need to be made about whether to prioritize water conservation efforts that reduce social disparities** – even if they might result in less water savings than programs that direct water conservation resources towards the biggest water users.

Values to Guide the Bay Area in Using Less Water, More Efficiently

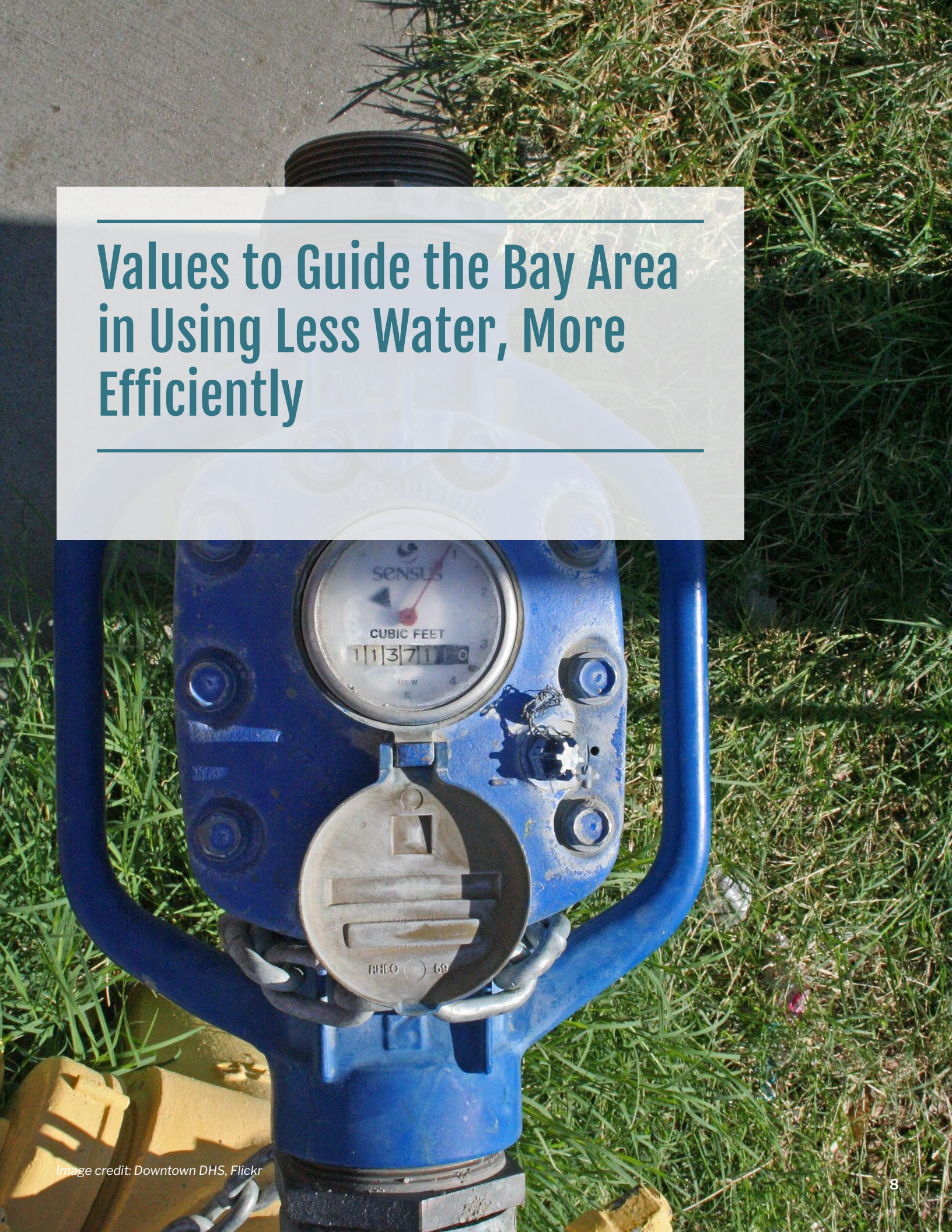


Image credit: Downtown DHS, Flickr

CORE VALUES

Maximize co-benefits

Prioritize water conservation and water use efficiency projects that also benefit other societal goals, such as improved wildlife and native plant habitat, reduced greenhouse gas emissions, increased carbon sequestration, increased urban greening, better environmental health outcomes, better water affordability, and fewer social disparities.

Integrate water system planning

Integrate planning for how to use less water with planning for other water systems (including recycled water and stormwater capture) on a larger watershed scale.

Use water efficiently

Focus on using less water to do the same tasks, for example by prioritizing water-efficient appliances. Advanced metering infrastructure, along with other household metering devices, can be installed to detect leaks in the distribution system, in commercial areas, and on private property.

Invite broad participation

Provide resources for education, outreach, and behavior change to promote a cultural shift to using less water.

Invest effectively

Financial investment in water saved through conservation and efficiency measures can pay off with greater water savings per dollar spent than investments in other new water supplies.

Ensure long-term sustainability

Ensure that water savings are measured and remain durable over time.

Use only what you need

Don't let water conservation come at the expense of livability of the urban Bay Area. This includes ensuring enough water use for basic human needs at home, while also investing water into creating or improving public green spaces in neighborhoods lacking in recreational areas and tree canopy. This can also counter the urban heat-island effect and provide migratory and transition pathways for urban wildlife.

Protect creeks and the Bay

Prioritize reducing irrigation runoff that can pollute urban waterways with fertilizers, pesticides and chloramine.[15]

Enable a just transition

Create "green collar" training programs and jobs that can support water conservation and efficiency efforts.

Broaden decision-making

Establish long-term relationships with community-based organizations and local Tribes and Tribal organizations to ensure equitable community participation in local decision-making about water conservation and efficiency priorities.

[15] UC Berkeley Office of Environment, Health and Safety, "Strawberry Creek Water Quality - 2006 Status Report."

Key Water Conservation Challenges and Solutions

Parking lot of the Mitchell Park Library and Community Center in Palo Alto, California, designed to support tree growth with minimal intervention and process stormwater on-site.

Image credit: DeepRoot, Flickr

During breakout discussion sessions and interactive activities, workshop participants characterized key challenges to equitably advancing water conservation and identified a set of potential solutions for overcoming these challenges.

Challenge: Water Affordability

In the long term, water use efficiency and conservation may enhance water affordability by delaying or forgoing the need to develop expensive new water supplies, by allowing water users to purchase less water, and by reducing the costs associated with water treatment and distribution. In some cases, efficient water use in households may also serve to reduce energy and wastewater bills.[16]

However, conservation can also pose challenges to water affordability. Much of the current cost of water goes towards fixed infrastructure costs for water treatment and distribution – many water agencies charge a fixed fee to cover the costs of building and maintaining infrastructure, plus a variable fee based on the volume of water used, which reflects the costs of treating and conveying the water to the tap. Because of this, water bills tend to be more expensive per unit of water when less is used, because the fixed fee stays constant. This is an especially big problem in urban areas with declining population, because there are fewer people to share the fixed costs of water infrastructure. Additionally, abrupt reductions in water use (as when conservation is called for during a drought) challenge the ability of water agencies to collect sufficient revenue to cover their costs unless they have reserved funding for this purpose, so they are forced to add a "drought surcharge" or raise rates in order to cover their costs.

Even before COVID, many Bay Area households had trouble paying their water bills, and job losses associated with COVID likely exacerbated the inability of low-income households to afford their bills. Though many water agencies placed moratoriums on water shutoffs due to lack of payment during COVID, water shutoffs resumed in 2022.[17] This is a critical health and environmental justice concern. **To ensure water is affordable for low income households, efforts towards improved water conservation and efficiency must consider their impact on water affordability.**

Conversely, water conservation efforts may make water more affordable for low-income households, by reducing the volume of water that they use.[18] Advancing water conservation equitably includes finding ways to support low-income water users as early adopters of water conservation technologies and practices.

Affordability Solution 1: Assistance Paying Water Bills

Some programs to ensure water affordability already exist, such as California's Low Income Household Water Assistance Program (LIHWAP). LIHWAP provides funding to low-income households to pay their water or wastewater bills. However, water agencies must be previously enrolled in LIHWAP for households in their service area to qualify. Taking better advantage of this assistance opportunity requires:

1. Outreach to water agencies to ensure they are enrolled in LIHWAP (as of October 2022, 511 of approximately 3000 water systems in California are enrolled).[19]

[16] Cooley, Shimabuku, and DeMyers, "Advancing Affordability Through Water Use Efficiency."

[17] Becker, "Help Paying Water Bills May Be on Way for Low-Income Californians."

[18] Cooley, Shimabuku, and DeMyers, "Advancing Affordability Through Water Use Efficiency."

[19] Dobbin and Fencl, "Who Governs California's Drinking Water Systems?"; California Low Income Household Water Assistance Program, "Water System Utilities - Enrollment Status List."

2. Outreach from enrolled water agencies to their constituents to ensure that households suffering financial hardship know about the program and can access the funds.

LIHWAP was established by the California Department of Community Services and Development in 2020 with one-time federal funding of $116 million. Getting serious about water conservation and affordability will require ongoing funding assistance for very low-income households to enhance the affordability of basic water supplies.

Affordability Solution 2: Equitable Access to Water Efficient Devices, Leak Detection, and Repairs

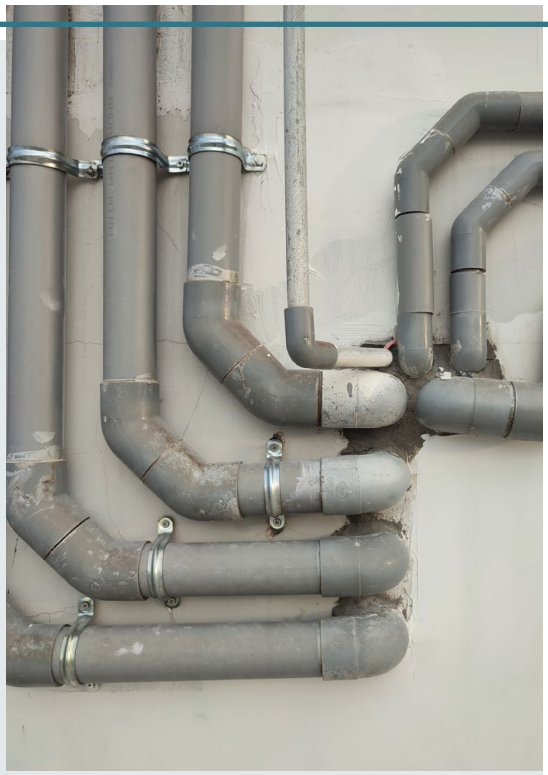
While using less water will likely result in a higher cost of water per unit, it does not have to result in higher water bills if households use water more efficiently. While many water agencies provide rebates for water efficient appliances, rebate programs privilege households that have enough cash on hand to front the money to purchase and pay for installation of a new toilet or clothes washer. Reimbursement from rebates often arrives weeks to months later.

Programs to make water-efficient appliances freely available, with water agencies paying for their direct installation, would make it more possible for the households with the lowest incomes to participate and result in more equitable access to water efficient devices. Free stores (whether online or in-person) or vouchers for water efficient devices are another way to improve access for lower-income households. Valley Water's online water conservation store offers one example.

Removing Barriers to Fixing Leaks: Leak Free Sacramento and San Antonio's Plumbers to People

Sacramento, California has developed a program called Leak Free Sacramento to help conserve water and make water bills more affordable for low-income families. Low-income homeowners who meet a set of eligibility requirements can call a city-contracted plumber for a house call to repair leaks indoors and outdoors, at no cost to the homeowner.

San Antonio, Texas, has also created an effective way for low-income families to reduce their water bills and conserve water. The water agency partners with San Antonio's municipal social workers to identify low-income families with leaky water fixtures. Then the water agency sends a plumber to make the repairs, at no cost to the resident. The water agency touts the program as one of their most cost-effective – they spend roughly $80 per acre-foot of water saved.[20]



[20] San Antonio Water System, "Plumbers to People Water Conservation Program."

Advanced Metering Infrastructure (AMI)

Every urban water user, whether a residence or a business, is connected to a water meter, which measures how much water is used. Advanced Metering Infrastructure (AMI) wirelessly transmits data about water usage to the water agency and the water user. This can have many advantages, including leak detection in real time. However, installing AMI and setting up the capacity for water agencies to process the resulting data can be expensive and logistically complex. Security of the water usage data is important, as some water users have voiced concerns that AMI will result in less privacy if the data are hacked. As of 2022, nearly 50 cities in California have adopted AMI to some extent, and more are in development.[21] Some water agencies, including Contra Costa Water District in the Bay Area, are also offering rebates for customer-installed advanced water meters, like Flume, that can detect leaks and monitor water use in real time.

[21] Ratan, Post, and Cox, "AMI Adoption."

Tariff on-bill financing, which is commonly used in the energy sector, is another method that can allow lower-income water users to take advantage of water conservation upgrades without an upfront cost to their household. In a tariff on-bill financing scheme, the water utility pays the up-front cost of a water efficiency measure (i.e., leak repair), then the utility reimburses themselves over time by taking the cost out of the water user's bill savings -- with a guarantee that the water user will not need to pay more than they already were before the upgrade. Targeting installation of water-efficient devices in the lowest-income households allows these families to benefit sooner from lower water bills.

Stopping water leaks has the potential to dramatically reduce water demand. Advanced Metering Infrastructure (AMI) has the potential to let water users and water agencies know in real-time how much water they are using, and therefore quickly identify leaks (for example, if water is being used late at night or when no one is home). Water agencies can enhance both water conservation and affordability by finding ways to equitably distribute AMI to both high water-using households and to low-income households, and to property owners as well as sub-metered to renters. To effectively use AMI data, water agencies will need to develop institutional capacity to manage and respond to the new data, including dedicated staff time, database development, and data security.

Affordability Solution 3: Water Rate Structures

Water rate structures determine how much each customer pays for water. Some water agencies charge the same rates for all customers, regardless of how much water they use. Other water agencies employ a tiered water rate structure, in which water users get charged more for using greater quantities of water within set "tiers" of water use. Other agencies use a type of tiered rates structure called "budget-based rates" for water, which set a reasonable "budget" for basic water use at no- to very low-cost that is tailored to household size, landscaped area, and weather, above which they charge higher rates per volumetric unit of water use. Some water agencies, including Marin Water in the Bay Area, waive all fixed fees for low-income water

users, and only charge for the volumetric rates of water.

In the Bay Area, local groundwater and some imported water supplies are relatively cheap, while sourcing water from water recycling or desalination can be more expensive. Rate systems can be designed to reflect the expense of supplying the water, such that the people using the least amount of water in their homes can benefit from the cheaper supplies, and increasing water use results in increasing rates that reflect the need for more expensive water supplies. This allows water agencies to pass on real costs of marginal water supplies or new water project development to the highest water users who are least sensitive to the cost of water.

While the details of tiered and budget-based rate structures can vary, the broader idea behind them is to equitably distribute the costs of water provision among the population, such that the people and businesses using the most water are proportionally paying more of the costs of getting water from more expensive supplies. However, figuring out fair ways to set tiers, to determine housing occupancy to allocate the basic "budget" in a budget-based system, and to factor population growth and new urban development into these rate systems can be complex.

Although there is broad agreement among water agency staff that tiered and budget-based rate structures are a more equitable way to finance water provision than uniform rates across all water users, these rate structures can be complex to implement in practice. First, it can be difficult to fairly allocate volumes of water to any given rate-based tier or budget. While some budget-based rates are based on per-capita water use, official counts of how many people live in a residence may dramatically diverge from reality. This is particularly true for households that include undocumented individuals, transient

Tiered- and budget-based rate structures for water in Southern California

Los Angeles Department of Water and Power uses a tiered-based model to determine water rates. They divide water use into four tiers, in which water rates increase with increasing tiers. The first tier includes ~6000 gallons per household per month, and is intended to include all basic indoor water use. The agency meets Tier 1 water demand with the least expensive water sources. The second and third tiers are for outdoor use, and are met using more expensive water sources. The water agency determines the second and third tiers based on lot size, temperature zone, and season. The fourth tier is for "excessive water use" and is met using the most costly water sources.[22]

At the Moulton Niguel Water District, each household is allocated 55 gallons of water per person per day for indoor use (with population estimates based on the Census data), and a water budget for reasonable outdoor use based on landscaped area of their parcel and real-time localized weather data. Water use above the budget results in higher rates – and the revenue from these higher rates is used to fund water efficiency programs within the District.[23] Moulton Niguel reports that implementing a budget-based rate structure dramatically advanced water-use efficiency, resulting in a reduction of over 1.3 billion gallons in peak summer water use.[24]

[22] Los Angeles Department of Water and Power, "Water Rates."
[23] Moulton Niguel Water District, "Water Budget Based Rates."
[24] Moulton Niguel Water District, "Proposition 218 Notice."

individuals, or unpermitted rental units, which could result in these households being shunted into a higher tier of water rates, despite low per-capita usage.

Next, California's Proposition 218 limits the ways in which water agencies can set water rates. While tiered water rates and budget-based water rates have periodically been challenged in court due to concerns about Proposition 218, the courts have affirmed that both budget-based water rates and tiered water rates can be designed to be in compliance with Proposition 218.[25] In short, for water agencies to comply with Proposition 218, the cost of water needs to be tied to cost of serving water to the parcel. Water agencies can structure budget-based rates so that the most efficient users, including low income households, can benefit from the lowest cost water supplies.

Despite these challenges, there are new tools available to help water agencies obtain the data they need to set up budget-based rate structures. Governor Newsom's move towards "Making Water Conservation a California Way of Life" paves the way towards more widespread implementation of budget-based rates and other equitable rate structures for water conservation.[26]

[25] Salt, "Adopting Conservation-Based Water Rates That Meet Proposition 218 Requirements."

[26] California Department of Water Resources and State Water Resources Control Board, "Making Water Conservation a California Water of Life."

Proposition 218

In 1996, California voters approved Proposition 218, which requires public agencies, including water districts, to set their rates on a cost-of-service basis. Among other requirements, Proposition 218 makes local water agencies prove that each water user benefits in proportion to their water rates, and that each user's water rates do not exceed the cost of providing water to that particular property.[27]

These requirements make budget-based rates complex and costly to implement, since the water agency must fund the studies to prove that any new rate structure is in compliance with Proposition 218. Proposition 218 also stipulates that property owners may not pay for a service in their water rates unless that service is directly available to them – which makes it complicated for water agencies to use rate-based revenue to provide programs (like turf replacement with native plants) to particular neighborhoods where they will be most useful or most equitable. Instead, these programs must be offered to everyone who pays water rates or funded with non-rate-based revenue (i.e., from grazing leases on land managed by water agencies).

In counterpoint, some policy analysts argue that water agencies' rebates for water-efficient appliances and landscape transformation that are funded with rate-based revenue should also be prohibited under Proposition 218 because low-income households effectively do not have access to these rebates because they are not able to front the cash up front, despite contributing the rates and fees that make such rebates possible.

[27] Hanak et al., "Paying for Water in California: Technical Appendices."

Challenge: Equitable Distribution of Landscape Transformation for Water Conservation

A significant portion of the Bay Area's urban water use goes to outdoor irrigation. When drought strikes, many water agencies renew their efforts to encourage replacement of water-hungry lawns with native plants and shrubs that use less water. However, wealthy families tend to benefit from turf-replacement programs more than low-income families,[28] in part because turf replacement programs only benefit homeowners, not renters. Not only do wealthier households tend to have bigger lots and more lawns, but they also tend to be able to access rebate programs for turf replacement more easily than lower-income households who may not have the money to spend up-front on drought tolerant plants and landscaping services. This is an area where tension exists between those seeking to attain maximal water savings and those seeking to advance water conservation most equitably – the wealthiest properties tend to use the most water for irrigation, so landscape conversion of these thirsty properties tends to provide more water savings than getting rid of small lawns in less affluent neighborhoods. Yet continued investment of public funds in subsidizing the wealthiest households concentrates benefits outside of low-income neighborhoods.

The issue of inequitable distribution of landscape transformation is compounded by the fact that many low-income neighborhoods in the Bay Area currently enjoy far less green space and shade than their wealthier counterparts.[29] This disparity can have serious consequences for both property values and ambient temperature. Drought response efforts in California, in particular efforts to curb outdoor irrigation, can cause additional tree mortality in cities,[30] especially in places where urban tree species were not chosen with future climate conditions in mind. In a hotter future, cities will be most livable and equitable if we plant more urban shade trees that will thrive in the future climate, and provide more public green spaces for recreation where evaporative cooling occurs, especially in the neighborhoods that currently lack these amenities. To realize this vision of urban green space, cities can ensure their urban trees have enough water to grow and thrive, even during droughts. Thus, to contribute to larger societal goal of social equity, water conservation efforts can work in the service of this vision by prioritizing water use efficiency (i.e., with drip irrigation) without compromising urban green spaces that can have multiple benefits for recreation, urban cooling, and habitat for native plants and wildlife.

Landscape Transformation Solution 1: Alleviate Barriers to Landscape Transformation

Because of Proposition 218, water agencies cannot use rate-based revenue to offer a service to some of their customers without offering it to all, which makes targeting water conservation to marginalized neighborhoods logistically challenging. However, water agencies can more equitably offer landscape transformation services in low-income neighborhoods by working with community-based groups to provide direct installation of drought-tolerant landscaping, instead of providing rebates. Mobile drought-tolerant plant nurseries could travel to households and allow residents to choose their plant and tree palette for their landscaping. To support

[28] Pincetl et al., "Evaluating the Effects of Turf-Replacement Programs in Los Angeles."

[29] "Heat Waves Hit Low-Income Bay Area Neighborhoods Harder Due to Less Trees, Shade."

[30] Ding, "SoCal Needs to Keep Vital Trees Alive despite Unprecedented Watering Restrictions."

long-term landscape conversion, water agencies can allocate funds to both property owners and to cities for long-term operations and maintenance of low-water landscapes, particularly in marginalized neighborhoods where increased resources can help sustain enthusiasm for low-water landscapes.

Landscape Transformation Solution 2: Focus on "Green Collar" Jobs

Along with direct installation, operations and maintenance of drought-tolerant landscaping, water agencies can fund local community-based organizations to develop job training programs for people to learn to design, build, and maintain drought-tolerant landscaping. One example is the Qualified Water Efficient Landscapers program, based in the North Bay Area. Where trust is lacking between communities or Tribes and public agencies, partnerships with trusted community-based or Tribal organizations offer a path for water agencies to effectively serve members of marginalized communities and / or Tribes through water conservation services, such as job training and/or direct installation of low-water landscaping.

Landscape Transformation Solution 3: Big-Picture Planning for Co-Benefits

To leverage funding and co-benefits for landscape transformation with water conservation co-benefits, water efficiency and conservation can be integrated into regional planning efforts, particularly those for climate change adaptation. Water conservation plans for landscape transformation that take a big-picture, multi-watershed perspective are most able to leverage funding from a variety of sources, as well as to consider co-benefits for stormwater management, reducing urban heat-island effect, and providing spaces for recreation.

Landscape Transformation Solution 4: Protect Urban Green Space

Municipal ordinances for landscaping can prioritize urban green spaces that provide amenities for recreation, public safety, urban cooling, and community values, even during droughts. Prioritizing water for grass that is used for recreation (i.e., in playing fields and parks) and green spaces that are highly valued by community members, such as community gardens, can preserve urban green amenities.

Landscape ordinances can take into account urban heat island indexes, to prioritize irrigation within historically hotter neighborhoods. To better protect public urban green space during droughts, municipalities using water for urban tree canopy, public parks, and school yards can be exempted from water restrictions. Minimizing urban heat island impacts and promoting urban greening are broader issues of interest beyond water agencies. This suggests an opportunity for collaboration and co-funding with other groups like public health experts and others from municipal government.

Challenge: Motivating Behavior Change

The amount of water that people in the Bay Area use is highly dependent upon their habits. Taking long showers, washing cars, and irrigating huge lawns are all learned behaviors - which can be un-learned as water conservation becomes more important. But motivating behavior change is complex, and water agencies are still learning ways to inspire water use efficiency among their customers. Collaboration with social scientists and behavior change experts can help elucidate additional pathways towards effective behavior change.

Additionally, catalyzing behavior to shift to more water-efficient devices can enable people to have the lifestyle they want without the water waste.

Behavior Change Solution 1: Develop Regional Priorities for "Saved" Water through Conservation Efforts

One of the motivations for Bay Area residents to change their behavior to use less water is a moral idea that they are doing "the right thing" for the environment and their community. This idea of doing "the right thing" can be informed by clear regional priorities about what the "saved" water will be used for, that are publicly articulated by water agencies, regional planners, community leaders, and other decision-makers. Will the "saved" water remain in rivers like the Tuolumne and Mokelumne, to ensure flows high enough for fish survival? Will it enable suburban development in Eastern Contra Costa County? Will it enable more dense development near transit centers? Will it prevent expensive capital investments in developing new water sources, like advanced water recycling or desalination? The answers to these questions are pivotal for urban water users to understand how using water more efficiently aligns with their personal values (or not).

Importantly, regulations can codify environmental uses for in-stream flows for "saved" water. Policies can also ensure new development is as water-efficient as possible to enable cities to meet regional housing needs without unnecessarily increasing water demand.[31]

Behavior Change Solution 2: Invest in Education and Outreach

In addition to regional priorities for allocation of the water saved through conservation efforts, water agencies can invest in education and outreach about both water conservation and the ways in which water conservation can advance the regional priorities. Although it may be hard for water agencies to measure the amount of water saved due to education and outreach efforts, these efforts are essential for motivating behavior change. People need to know the options for conserving water and be able to make choices that reflect their values. Eventually, education and outreach may lead to cultural shifts in how Bay Area residents value and use water.

[31] Adams, "Water Conservation Efforts Paying off in Santa Monica."

One area in which education and outreach efforts about water conservation can be expanded is in demonstrations of how water conservation can improve communities. While some demonstration low-water landscapes exist, including one maintained by the Alameda County Water District,[32] additional demonstrations can build transparency and foster relationships among water agencies and community groups with regards to low-water landscaping design and implementation, job training and development, and decision-making.

Education and outreach efforts can target individual water users (homeowners and renters) as well as elected officials, multi-unit housing developers and owners, and businesses. Local elected officials may use the information gained to require new developments to be water efficient and to creatively implement water-efficient practices in multi-unit buildings. Individuals may respond more to comparisons of water use with neighbors or to others with a similar lot size than to just personal data. Information on water bills about water use in comparison to others with similar properties provides a mechanism for social norming as a means for changing habits. Basically, this gives direction on social cues and fitting in.[33]

Members of marginalized communities and Tribes may distrust public agencies, so water agency staff are not always the most effective spokespeople for education and outreach efforts. Instead, water agencies can fund and provide resources for community groups and Tribes to do outreach to their own constituents, while undertaking longer term plans and projects to address community- and Tribal-identified needs and establish trust.

To support these efforts, water agencies throughout the region can work together to provide funding to coordinate multi-lingual, culturally competent education and outreach about water conservation region-wide.

Motivating Behavior Change Solution 3: Celebrate Successes

Water conservation has played an immensely important role in the Bay Area's current water use patterns, but there is little information available that publicizes this fact or data that quantify the ways in which water conservation has allowed residents of the Bay Area to avoid more capital investments in water

[32] Alameda County Water District, "ACWD's Water-Efficient Landscape Demonstration Garden."

[33] Schultz, Javey, and Sorokina, "Social Comparison as a Tool to Promote Residential Water Conservation"; Janssen, "Modelling Social Norms of Water Conservation."

infrastructure. Celebrating the successes of water conservation can go a long way in promoting more water-conserving habits.

Similarly, individual water users can be celebrated for water-conservation successes through prizes, raffles, or other incentives for doing a good job at using water efficiently.

Challenge: Compatibility with Existing Water Infrastructure

While using water efficiently is beneficial for many different reasons, water conservation can challenge existing water and wastewater infrastructure systems in several ways. Water conservation efforts, when successful, mean that cities use less water – and therefore that water spends more time in the distribution system. Maintaining microbial water quality over this longer time requires greater exposure to chlorine, which can result in more formation of toxic chlorine disinfection byproducts in drinking water.[34] The East Bay Municipal Utility District (EBMUD) experienced this at some of their reservoirs in 2017,[35] and this is a broader concern that should be considered if less water is used in the future.

Indoor water conservation efforts also result in more concentrated sewage. This can pose problems for existing wastewater infrastructure, including more corrosion of pipes and pumps, more sewage back-ups, stronger smells at wastewater treatment plants, and greater energy use per volume of treated water required for wastewater treatment. Since many of the communities the California EPA has designated as "Disadvantaged" in the Bay Area are in the areas with flatter topography,[36] there is the possibility that sewer backups and other negative effects on wastewater operations exacerbated by water conservation will be concentrated in disadvantaged communities.

In addition, as residents conserve more water indoors, less volume of wastewater means there is less water available for recycling. In some parts of the Bay Area, like in the Tri-Valley area of the East Bay, recycled water demand already surpasses supply in the summer. Wasting water indoors so that the sewage can be recycled is not an efficient option – and it is also important to acknowledge that the current agreements, institutional frameworks, and investments that have supported recycled water use to date in the Bay Area are based upon set volumes of wastewater, which may prove to be antiquated in a more water-efficient future.

While efficient use of water has myriad benefits, it also means that in a drought year, people may be less able to change their behavior or their irrigation patterns to use less water (because they've already done it!). This phenomenon is known as "demand hardening" to water managers. Demand hardening challenges water agencies to prepare for droughts when there isn't a lot of "flex" in the water supply system, and some water managers have presented the fear of demand hardening as a reason for not pushing the acceleration pedal on water conservation.[37]

Compatibility with Existing Water Infrastructure Solution 1: Proper Prior Planning

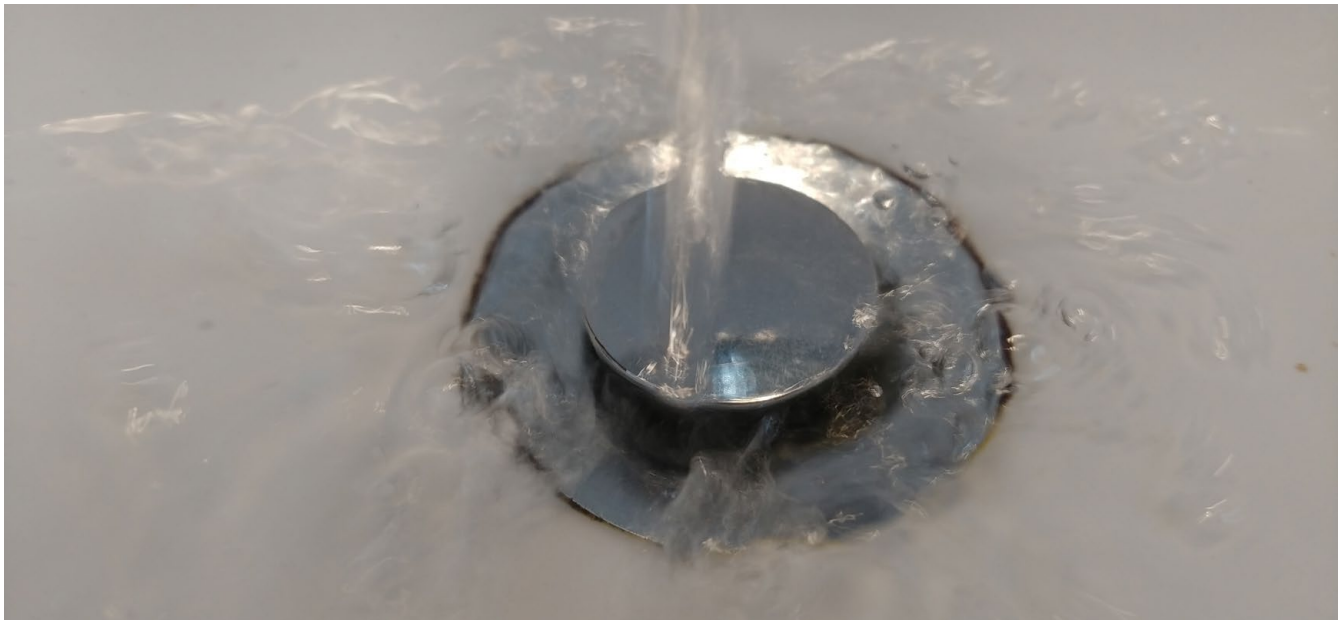
Engineering solutions exist for problems like corrosion, back-ups, and stronger smells posed by water conservation to wastewater

[34] Nguyen, Elfland, and Edwards, "Impact of Advanced Water Conservation Features and New Copper Pipe on Rapid Chloramine Decay and Microbial Regrowth."

[35] Dinkelspiel, "EBMUD Works to Rid Berkeley Water of Compounds That Can Raise Risk of Cancer."

[36] Office of Environmental Health Hazard Assessment, "CalEnviroScreen 3.0."

[37] Alliance for Water Use Efficiency, "An Assessment of Increasing Water-Use Efficiency on Demand Hardening."



systems.[38] However, for these engineering solutions to be implemented in a timely and equitable way, water agencies and wastewater agencies need to maintain clear lines of communication and engage in shared planning. Historically, water agencies have dramatically overestimated the future water demand in their service area due to not accurately accounting for water conservation.[39] Accurate forecasting of water conservation can enable re-sizing, retrofitting, or modifying wastewater pipes and treatment systems for future water use, and changes can be incorporated into wastewater systems as capital improvements arise.

Our drinking water provision systems have been historically sized for greater per-capita use, with storage tanks and pipes designed to be bigger than water-conserving communities will need them to be. More accurate methods for forecasting water use and conservation can also enable water agencies to appropriately size water storage tanks and pipes going forwards and integrate these estimates into capital improvement planning. One complication here lies with having adequate water pressure for firefighting if water distribution pipe diameters and storage tank sizes are reduced to more accurately reflect more water-efficient use. Cities can get around this problem in several ways. Some big cities like New York and Chicago have special high pressure hydrants on a separate system to provide enough water to fight fires in apartment buildings. In Germany, fire departments are set up to pump water out of ponds and streams. Locally in the Bay Area, some cities like Albany require residential properties to include sprinklers inside.[40] Determining firefighting strategies for Bay Area municipalities is an important part of water conservation planning.

Re-assessing the way conservation factors into future water supply planning is critical to understanding how much additional water can realistically be conserved during a drought. In

[38] Blanksby, "Water Conservation and Sewerage Systems."

[39] Sonali Abraham, Diringer, and Cooley, "An Assessment of Urban Water Demand Forecasts in California."

[40] Sedlak, *Water 4.0*.

other words, models to forecast water use can be improved by accurately assessing where there may be flex for additional conservation during drought years. Where tiered water rate structures exist, looking at the water use in the highest tiers gives good indication of opportunities for further water conservation during a drought.

Compatibility with Existing Water Infrastructure Solution 2: Encourage Outdoor Water Efficiency and Conservation

Outdoor water use efficiency and conservation can result in huge water savings, without jeopardizing wastewater system operation at all. This can include using less impervious materials and building bioswales in cities so that stormwater can infiltrate into soils and become available to plants, using drip irrigation instead of sprinklers, eliminating non-functional turf, prioritizing low-water and drought-tolerant plant species, and utilizing moisture-sensing irrigation so that plants aren't over-watered in the rain, among other options. Prioritizing efforts for outdoor water conservation over indoor water conservation is especially helpful in areas where there is more demand for recycled water than there is available supply.

Compatibility with Existing Water Infrastructure Solution 3: Monitoring

Wastewater agencies monitor the characteristics of the influent sewage to their wastewater treatment plants, and this can be used to effectively track if influent is getting more concentrated due to water conservation efforts and to be able to respond appropriately. This monitoring could support real-time operations and inform adaptation efforts, such as replacing lost influent with previously uncaptured sources like "urban drool" from storm sewers.

Compatibility with Existing Water Infrastructure Solution 4: Invest in Infrastructure for Drought Security

To prepare for concerns about demand hardening in response to water conservation, water agencies can invest in infrastructure as needed for drought security, including methods of water storage, so that there is a bigger buffer during drought years. This can include everything from cisterns for capturing stormwater to aquifer recharge and groundwater banking. It can also include securing agreements to purchase water from other suppliers during drought years.

Partnerships to Advance Equitable Water Conservation

Rain gardens capture storm runoff at Sacramento State University.

Image credit: Jessica Vernone Sacramento State University, Flickr

This report has named several of the challenges to equitable water conservation and identified a suite of potential solutions to these challenges.

However, enacting most of these solutions will require greater collaboration and partnerships between and among water and wastewater agencies, Tribes and tribal organizations, and community groups including from marginalized communities.

Additionally, water agencies can develop stronger partnerships with public health departments, municipal governments, and energy utilities as co-beneficiaries of water conservation to integrate planning and create opportunities for funding. These types of partnerships will be essential for developing regionally effective communications and demonstrations about water conservation and Advanced Metering Infrastructure, for developing and implementing regional job training programs for equitably engaging in water-efficient urban landscape transformation, for setting regional priorities for "saved" water, and for regional administration of direct-install and rebates of water-efficient devices.

Advancing water conservation most equitably will require co-production of water conservation plans and goals, including expertise from resource managers, land use planners, marginalized community members and Tribes. Additionally, it necessitates ongoing engagement and shared decision-making, and transparency and accountability about what community engagement efforts produce and implement. Effective partnerships can help ensure water conservation is integrated into broader regional planning efforts for climate resilience, social justice, water supply and wastewater treatment, and ecological sustainability.

Ongoing Research Needs

RESEARCH NEEDS

1. **Opportunities for water conservation and efficiency:** What are the biggest gains in water conservation and efficiency in the Bay Area? What are the cost-savings associated with right-sizing additional future infrastructure based on projections of efficient use?

2. **Water conservation and demand hardening:** In a future when water is used most efficiently in the Bay Area, how will having different quantities of water available in reserve or on demand (i.e. via groundwater banking) affect basic needs, quality of life, urban green space, and economic outputs during a severe drought? What are the social, economic, and public health implications of having different amounts of water in reserve under different future scenarios?

3. **More granular water use data:** To best inform efforts for outreach and behavior change, for water use-efficiency, water agencies need more granular data about water use, along with more refined analysis of how water use correlates with income, race, zip code, and other demographic factors.

4. **Navigating Proposition 218:** How have other California communities navigated Proposition 218 to provide equitable services, including providing more funding or support for residents who need it more? What have been successes in designing incentive programs to specifically benefit water users in marginalized communities and Tribes?

5. **Motivating behavior change:** What motivates long-term behavior change in water use patterns? What does the literature say about social norming and its role in water conservation? How does this differ regionally and among different demographic groups?

6. **Equity-based rates:** How can water rates be best structured to address water affordability and equity?

7. **Quantifying benefits of water efficiency and conservation:** What have been the benefits and avoided costs of water conservation measures to date in the Bay Area?

8. **Estimating future water demand:** Past assessments have over-estimated future water demand, resulting in over-investment in infrastructure and stranded costs. Water agencies need more accurate models for forecasting future water demand that incorporate new policies, new technologies, and behavior change.

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APPENDIX A
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Marin Municipal Water District

Monterey One Water

NSF

ReNUWIt
Re-inventing the Nation's Urban Water Infrastructure

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Est. 1899

San Francisco Water Power Sewer
Services of the San Francisco Public Utilities Commission

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