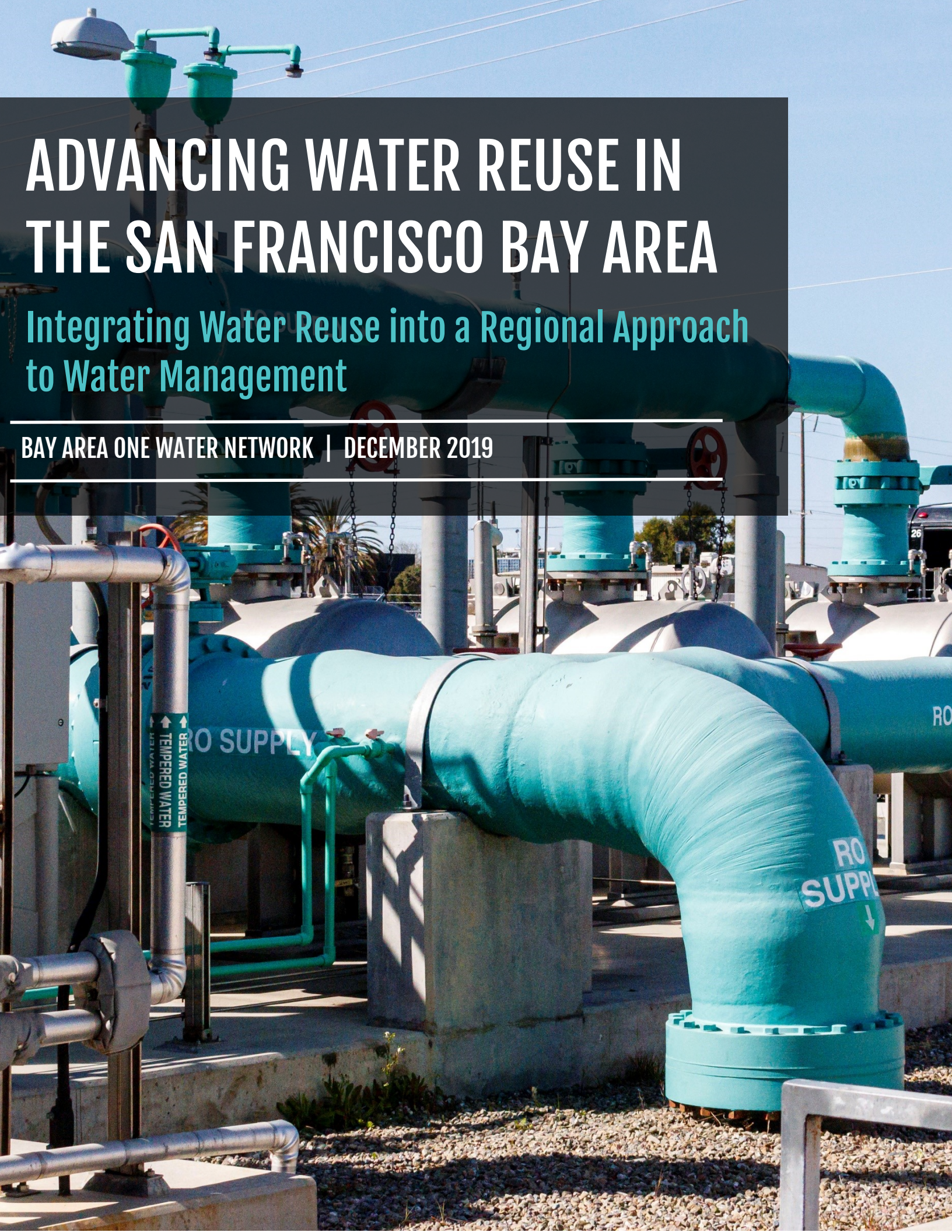
ADVANCING WATER REUSE IN THE SAN FRANCISCO BAY AREA

Integrating Water Reuse into a Regional Approach to Water Management

BAY AREA ONE WATER NETWORK | DECEMBER 2019



ABOUT THIS REPORT

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This report is the second in a series 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 data and research gaps, we aim to provide decision-makers with tools to meet the Bay Area's future water needs. An integrated approach to water resources management that includes water reuse of different forms and scales will allow municipalities, cities, private developers and utilities to meet future water demands in a way that is both economically feasible and consistent with the Bay Area's values.

This report presents the findings from a two-day workshop focused on water reuse opportunities and challenges in the Bay Area, held in Berkeley, California on December 17-18, 2019. At the meeting, participants considered different forms of water reuse as potential water supply opportunities for communities throughout the region. Forms of water reuse discussed included building- and community-scale onsite reuse, as well as centralized reuse for irrigation, habitat restoration, shoreline resilience, and potable uses. This report contextualizes the Bay Area's water reuse opportunities within broader efforts across California and the nation, describes local case studies and lessons learned about innovative water reuse, and presents the regional drivers for the practice. Finally, the report delineates potential actions to advance opportunities for water reuse in the Bay Area.

The Berkeley Water Center and Meridian Institute prepared this report with support from the sponsors of the Bay Area One Water Network, the National Science Foundation's Engineering Research Center for Re-Inventing the Nation's Urban Water Infrastructure, and the US Environmental Protection Agency. It reflects synthesis and interpretation of presentations and discussions from the December 2019 workshop, but is not intended to be a comprehensive assessment of the opportunities for water reuse in the Bay Area. Rather, the intent is to spur further consideration, discussion, and action.

See Appendix A for a list of workshop participants.

For more information about the Bay Area One Water Network, please visit www.bayareawater.org or contact Sasha Harris-Lovett (sharrislovett@berkeley.edu).

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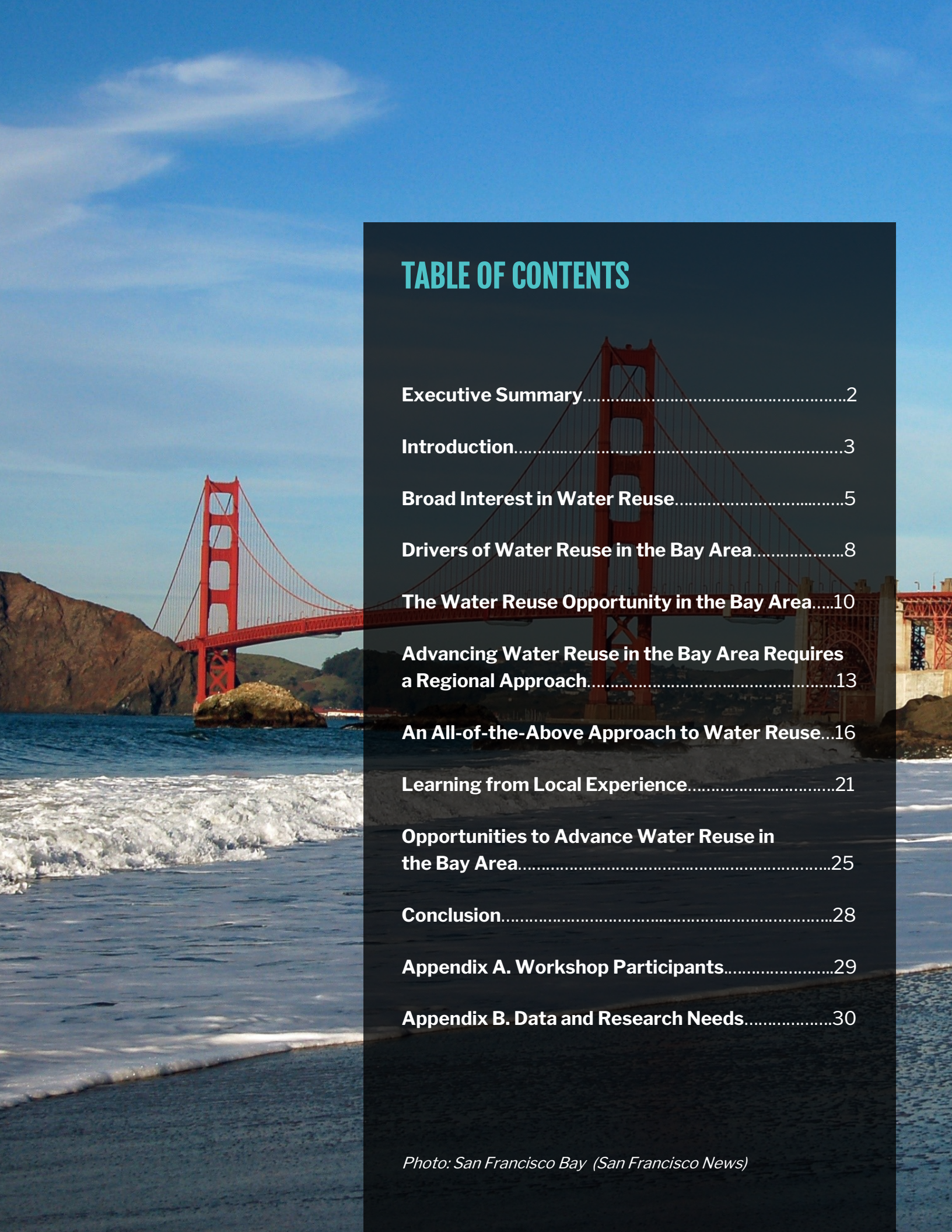

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Photo: San Francisco Bay (San Francisco News)

EXECUTIVE SUMMARY

This report provides a summary and synthesis of the Bay Area One Water Network's workshop on advancing water reuse across the San Francisco Bay Area, held December 17-18, 2019 in Berkeley, California. The workshop brought together a diverse group of professionals representing drinking water and wastewater utilities, businesses, regulatory agencies, non-profits, and academia to discuss ways in which water reuse could be integrated into a regional approach to water management in the Bay Area.

With the prospect of more severe droughts in California's future, and other stresses on urban water, Bay Area water managers are seeking cost-effective solutions to enhance the resilience and sustainability of their water supplies while also maintaining ecosystem health. Water reuse, both for potable and non-potable purposes, is one potential water source that can help diversify the region's water supply portfolio. There is broad interest in water reuse across the state and the nation. In the Bay Area, water managers and other stakeholders are interested in water reuse because it can allow for appropriate use of critical water resources, provide environmental benefit by reducing the region's demand for imported water, efficiently meet regulations on wastewater discharge, and burnish a "green" reputation for the implementing organization. A regional approach to water reuse can ensure the coordination and cooperation necessary for planning and implementing water reuse projects, enhance opportunities for funding, and allow water managers to make informed decisions about site-specific opportunities for water reuse. Having plans for water reuse prepared in advance can facilitate action on water reuse projects when opportunities for funding are available.

Workshop participants considered four opportunities for water reuse in the Bay Area, all of which are likely to play a role in the region's future:

1. Centralized non-potable reuse (i.e., for irrigation, shoreline resilience in nature-based solutions like horizontal levees, and industrial uses)
2. Onsite and community-scale non-potable reuse (i.e., for landscape irrigation, cooling, and toilet flushing)
3. Graywater reuse (i.e., household-scale use of laundry and shower water for landscape irrigation)
4. Potable water reuse (i.e., groundwater recharge, reservoir augmentation, and direct potable reuse)

As workshop participants discussed local experiences and opportunities, it became evident that advancing water reuse in the Bay Area depends upon addressing specific gaps and barriers in the region. To advance water reuse, the Bay Area can:

- Improve institutional support
- Evaluate regulatory action
- Develop collective financial capacity
- Conduct research to address data gaps
- Standardize communication strategies
- Jointly support both centralized and onsite water reuse systems that provide multiple benefits and drive innovation

INTRODUCTION

Landscape irrigated with recycled water

The San Francisco Bay Area, like much of California, is poised to recycle much more of its municipal wastewater in the coming decades. The drought of 2011-2017 has led to an increased recognition of the need to diversify the region's water supply portfolio at the same time that engineers and regulators are becoming more confident in the ability of water reuse to serve as a safe and cost-effective solution. Water reuse has the potential to reduce regional reliance on imported water, contribute to a "circular economy" in which fewer resources are wasted, decrease the regional economic impacts of a sustained drought, and reduce pollutant loading to the San Francisco Bay.

The ways in which water reuse projects are implemented in the region will determine how these benefits are realized. Presently, many entities in the Bay Area are pursuing different types of water reuse projects. Water and wastewater utilities are increasing their capacity to recycle municipal wastewater for irrigation, industrial and potable uses. Simultaneously, some corporate and university campuses, real estate developers and water utilities are pursuing onsite water reuse at a building- or community-scale.

Water reuse in the Bay Area will likely continue to take different forms. However, a lack of coordination could lead to economic inefficiency and send a mixed message to members of the public and decision makers who support and finance water reuse projects. Communication of common goals and development of a shared understanding of drivers for water reuse among different stakeholders, agencies, and organizations can better integrate water reuse systems that serve local Bay Area communities. Cooperation between water agencies and other stakeholders can also help identify opportunities for regional-scale water reuse projects that improve water system resilience, are economically feasible, and provide environmental benefits.

Although technological improvements continue to make water reuse practices more efficient, advancing water reuse is not a purely technical challenge. It will require planners, advocates, entrepreneurs, regulators, scientists and engineers to build an "innovation ecosystem" throughout the region to support different types of water reuse projects. Developing relationships among people in these different professional roles in the Bay Area will provide the foundation for a path forward. New technologies, innovative partnerships, and clear communication of the challenges and benefits of different types of water reuse projects can help guide an integrated and resilient water future.

Collaborating for Integrated Solutions

To assess the opportunities for and barriers to advancing water reuse in the San Francisco Bay Area, the Bay Area One Water Network held a workshop for a group of thought-leaders and knowledgeable experts from the region's drinking water and wastewater utilities, city governments, advocacy groups, non-governmental organizations, land-use planning groups and regulatory agencies (see attendee list in Appendix A). The workshop was designed to add value to ongoing discussions in the region by identifying drivers, shared goals, and barriers for future water reuse projects in the Bay Area; sharing lessons and technical information about local water reuse projects, as well as identifying data and research gaps; and defining actionable recommendations for advancing water reuse in the Bay Area. The workshop was also intended to strengthen professional relationships among the participants in order to build a robust network of stakeholders who can collaborate to advance water reuse projects.

BROAD INTEREST IN WATER REUSE

Water recycling plant operators remove microfiltration filters

Water reuse has received considerable attention across the nation. Although only about 6.6% of the municipal wastewater generated in the United States is currently reused,[1] the contribution is higher within some cities facing water stress and is poised to grow dramatically in the coming decades. At the federal, state, and local levels, policy-makers have strengthened calls to recycle wastewater for industry, environmental restoration and municipal water supply; there is increasing interest in both non-potable and potable uses.

In California, 16% of municipal wastewater (714,000 acre-feet per year) is reused,[2] with much of the recycling taking place in Southern California. The Bay Area hovers around the national average for water reuse, with 6.8% of the municipal wastewater produced in the nine-county region currently being reused.[3] In the Bay Area, recycled water is primarily used for landscape irrigation, with 10% of the total used to irrigate golf courses.[4] In future decades, it is likely that recycled municipal wastewater in the Bay Area will continue to irrigate landscapes and green spaces, with more being used for commercial uses, habitat and wetland restoration and as a drinking water supply source. In addition, recycled water use may become more popular as a means of decreasing the water footprint of new developments and campuses.

Water reuse initiatives at the federal and state level, described below, contextualize the Bay Area's growing interest in water reuse as summarized here.

National Water Reuse Action Plan

Released in September 2019, the Environmental Protection Agency's (EPA) draft National Water Reuse Action Plan outlines a suite of actions pertaining to policy, technology, workforce development, and outreach to bolster water reuse across the nation. A hallmark of the National Water Reuse Action Plan is its emphasis on integration and coordination of water reuse programs, policies, and research across agencies and jurisdictional boundaries. Suggested actions in the Plan include actions to: "support a talented and dynamic workforce," "promote technology development," and "facilitate financial support for water reuse."[5] The National Water Reuse Action Plan provides a framework for the EPA to support innovation in the water sector and support integrated water planning.

Governor's Water Resilience Portfolio for California

In April 2019, California Governor Gavin Newsom signed an executive order to support the creation of a Water Resilience Portfolio for the state.[6] It directs state agencies to prioritize multi-benefit approaches for water infrastructure, embrace innovation, and encourage regional collaboration. The draft Water Resilience Portfolio, released in January 2020, contains an explicit goal of supporting local and regional agencies' ability to recycle water by increasing funding for water reuse projects and by creating, streamlining and updating regulations for both potable and non-potable water reuse projects.[7]

California State Water Board's Recycled Water Policy

The California State Water Quality Control Board's Recycled Water Policy affirms state-level support for recycled water as a means of diversifying water supplies. The Policy sets targets for recycled water in California: 1.5 million acre-feet per year in 2020 (roughly double the amount of water reuse as relative to 2015 levels), and 2.5 million acre-feet per year by 2030. In acknowledgement of the potential health concerns associated with potable water reuse, the California State Water Resources Control Board includes a provision to convene a Science Advisory Panel every five years to guide actions related to contaminants of emerging concern in recycled water.[8]

[1] United States Environmental Protection Agency, *National Water Reuse Action Plan Draft*, 2019

[2] Calculated based on 714,000 AFY wastewater reused and 4 billion gallons/day (4.48 million acre-feet/year) municipal wastewater effluent produced in CA, California State Water Resources Control Board, '2015 California Municipal Wastewater Recycling Survey', 2015 and American Society of Civil Engineers, 'Report Card for California's Infrastructure', 2019

[3] Calculated based on 987.873 MGD effluent (1,106,601 acre-feet/year) in the region, from San Francisco Bay Regional Water Quality Control Board, 'Water Quality Control Plan for the San Francisco Bay Basin', 2019

[4] Calculated from Table 4 in California State Water Resources Control Board.

[5] United States Environmental Protection Agency.

[6] State of California Executive Department, *Executive Order N-10-19*, 2019

[7] California Natural Resources Agency, California Environmental Protection Agency, and California Department of Food and Agriculture, 'California Water Resilience Portfolio Draft', 2020

WateReuse *California Action Plan*

WateReuse California is a state-level arm of a national advocacy organization for water reuse which has close ties to many of the state's large water and wastewater utilities. The organization released a California Action Plan in July 2019 to guide priorities and strategies for advancing water reuse in the state. The California Action Plan is largely focused on strategies to support potable reuse, which is an area of considerable interest within that state.

California Senate Bill 332: Wastewater treatment — recycled water

In February 2019, State Senators Hertzberg and Weiner introduced Senate Bill 332 (SB-332), which would amend the state's water code to require stark reductions in the volume of wastewater effluent discharged to the ocean (50% reduction in dry weather flows by 2030, and 95% reduction by 2040). The bill is still under consideration by Senate committees.[9] Although the fate of SB 332 is uncertain, the possibility of a legislative mandate for phasing out ocean discharge of wastewater has initiated a dialogue within California's municipal wastewater and water recycling community about future investments in water reuse.

Senate Bill 966: Onsite treated non-potable water systems

In 2018, California Legislature passed Senate Bill 966, which requires the State Water Resources Control Board to set regulatory standards for onsite non-potable water reuse by 2023. This bill will accelerate implementation of onsite non-potable water reuse projects across the state by streamlining permitting processes and ensuring that recycled water in onsite systems is safe for its intended uses. Starting in January 2024, local programs formed by cities, counties and/or utilities will be responsible for managing permitting of onsite non-potable water reuse systems. Work is needed in the short term to bolster the formation and adoption of local programs across the Bay Area.

[8] California Environmental Protection Agency State Water Resources Control Board, 'Water Quality Control Policy for Recycled Water,' 2018.

[9] Robert Hertzberg and Scott Weiner, *Wastewater Treatment: Recycled Water*, 2019.

Car wash using recycled water

DRIVERS OF WATER REUSE IN THE BAY AREA

Landscape irrigated with recycled water

The Bay Area is a large and diverse region, and many different drivers for water reuse exist in specific local contexts. Clarity and transparency about ways in which proposed water reuse projects can benefit local communities can ensure alignment with stakeholder values and spur enthusiasm from elected officials and members of the public. Various stakeholders have different reasons for pursing water reuse, with some of the drivers below being more important in certain areas.

Create a more resilient and secure water supply

Diversifying where and how Bay Area residents get their water creates a more resilient and secure water supply. Water reuse can provide an additional supply that complements other water resource investments on imported water, local groundwater, stormwater capture and conservation.[10] In contrast to imported water, recycled water is locally-controlled and drought-resistant. Recycled water offers some measure of independence from the uncertainty in water supply associated with a changing climate and future regulations that might curtail the amount of imported water that communities receive. Resilience is not a feature of many current water supplies in the Bay Area; developing resilience may require additional costs above those of many current water sources.

Appropriate use of a critical resource

Water reuse can help satisfy a moral desire held by many Bay Area water professionals, elected officials and members of the public to use water in a way that is most sustainable for the environment and the region's communities. One aspect of this idea is the creation of water systems that use 'fit-for-purpose' water, which presumes that water of the highest quality should be reserved for potable use. Such an approach is considered by its supporters as an effective way to optimize the use of energy and resources while still protecting public health and the environment.

[10] Luthy, Richard G., Jordyn M. Wolfand, and Jonathan L. Bradshaw. "Urban Water Revolution: Sustainable Water Futures for California Cities." *Journal of Environmental Engineering* 146, no. 7, 2020.

Provide environmental benefits

There is widespread understanding that reducing the Bay Area's water imports could provide environmental benefits by helping restore ecosystems and wildlife habitat in the Delta and in the Tuolumne and Mokelumne River watersheds. By using imported water more than once, water reuse can potentially reduce the region's existing water imports, as well as potentially prevent future increased water imports if water demand in the Bay Area increases. Other potential environmental benefits associated with water reuse include prevention of saltwater intrusion into coastal aquifers (by way of groundwater recharge with recycled water) and use of recycled water for habitat restoration projects.

Efficiently meet regulations on wastewater discharge

Wastewater effluent discharge is regulated by National Pollutant Discharge Elimination System (NPDES) permits managed by the EPA, which are designed to protect water quality and ecosystems in receiving bodies of water. In some cases, meeting these regulations can be costly, as in the case of potential regulation of nutrients in the San Francisco Bay. Water reuse could provide a cost-efficient way to comply with wastewater regulations, for example by diverting treated effluent to irrigation systems that do not drain to the San Francisco Bay.

Provide a cost-effective water resource

There are few options for new water resources to meet existing and new water demands in the Bay Area that are likely to grow as the population grows. Water reuse can be a cost-effective way to meet these demands when compared with other potential local water supply options like seawater desalination or capture.[11]

Burnish a "green" reputation

Water reuse can help utilities, developers and companies create a positive image among consumers and community members. This can help attract and retain employees by promoting a culture of innovation and sustainability. It can also give members of the community a sense of social and environmental responsibility about the places they live and work.

[11] Cooley, Heather, and Rapichan Phurisamban. *The cost of alternative water supply and efficiency options in California.* Oakland, CA: Pacific Institute, 2016.

THE WATER REUSE OPPORTUNITY IN THE BAY AREA

Landscape irrigated with recycled water (purple boxes)

Although the cost of water reuse is high relative to existing water supply options, there are compelling reasons to invest in water reuse across the region.

Vulnerability of existing supplies

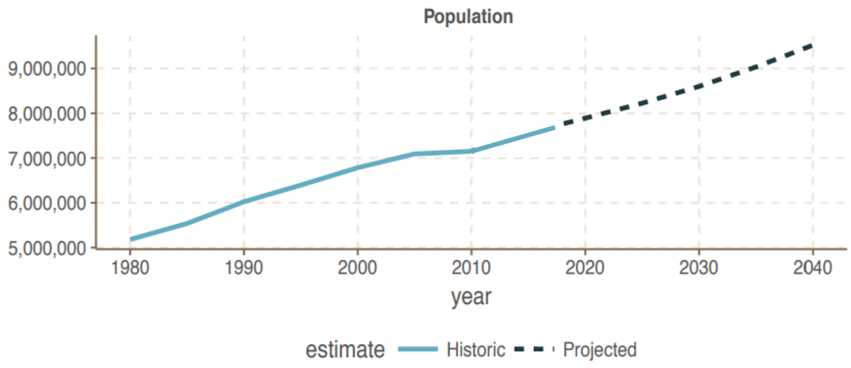
Bay Area communities rely upon various combinations of several key water sources: imported water from the Tuolumne, Mokelumne, and Russian Rivers; diversion from the Sacramento-San Joaquin Delta; local groundwater aquifers; and rain that is captured in local reservoirs. Approximately two-thirds of drinking water in the Bay Area is imported, while one-third is derived from local sources (i.e., groundwater and rainfall). Climate change will diminish the overall amount of Sierra snowpack, and cause snowpack to melt earlier in the year. These changes likely will limit the ability of existing infrastructure to deliver water to the region, especially in the dry summer and fall months. In a high-emissions climate change scenario, Sierra snowpack is expected to decline by 80% by the end of the 21st century.[12] In addition, local precipitation is expected to vary dramatically year-to-year, and longer droughts will likely become more common.[13]

Diversifying water supplies by increasing the amount of recycled water is one strategy for improving water supply reliability and stewarding the state's natural resources in the face of a changing climate. A diversified water portfolio with more local water sources also could increase resilience in the region by providing additional means of coping with hazards like earthquakes, fires and failure of levees in the Sacramento-San Joaquin Delta.

Changing social and environmental conditions

The Association of Bay Area Governments predicts that the Bay Area's population will grow by 2.1 million people between 2010 and 2040, representing a 30% increase.[14] Depending on growth patterns, this increase will stress water supplies in some areas, despite increased adoption of water-efficient appliances and changes in landscaping practices.

In addition, freshwater flows into the Bay-Delta estuary are considered insufficient to support ecosystem health.[15] As a result, diversions of environmental flows to Bay Area drinking water suppliers are likely to decrease in the future to preserve the Bay-Delta ecosystem. The Bay Area prides itself on its environmental ethos, and many residents believe that they have a responsibility to take care of waterways and the species that depend on them. While it is likely that conservation will be instrumental to meeting some of our water supply shortfalls associated with increasing population and decreasing supplies, it comes at increasing costs, both in terms of installation of plumbing and fixtures as well as less greenery to provide cooling and aesthetic beauty.



Projected population growth in the Bay area (Association of Bay Area Governments)

[12] David Ackerly et al., *California's Fourth Climate Change Assessment: San Francisco Bay Area Summary Report*, 2018.

[13] Ackerly et al.

[14] Association of Bay Area Governments and Metropolitan Transportation Commission, 'Plan Bay Area 2040', 2017

[15] San Francisco Estuary Partnership and Delta Stewardship Council, 'State of the Estuary 2019: Status and Trends of Indicators of Ecosystem Health', 2019 .

Although water reuse provides a means of meeting future demands, the way in which it is implemented could have unintended consequences. For example, California law mandates that new developments must prove adequate water supply exists before they are allowed to build.[16] Tensions can arise if a proposed water reuse project gains support from some stakeholders because of a desire to reduce imported water, but instead the project is considered an additional water supply that facilitates increased development.

Vulnerability and shortcomings of existing wastewater infrastructure

As much of the state's wastewater infrastructure nears the end of its design life, it becomes costlier to maintain existing levels of service.[17] Though the need to replace obsolete infrastructure could complicate efforts to obtain funding for new water reuse projects, aging infrastructure may also give decision-makers an opportunity to rethink existing practices and transition away from prior approaches, like conveying water long distances and constructing massive dams.

In the Bay Area, sea level rise threatens operations of many wastewater treatment plants located on or near the shoreline.[18] In addition, existing wastewater treatment systems may not be adequate to protect the Bay from the effects of nutrients[18] and contaminants that are not yet regulated.[20] Onsite or community-scale water reuse may provide a means of making urban wastewater systems more resilient to sea level rise while also diverting contaminants in effluent away from the Bay. Similarly, using recycled water to irrigate constructed treatment wetlands like horizontal levees could serve to protect existing wastewater infrastructure while additionally treating contaminants of emerging concern before effluent enters the Bay.

[16] Ellen Hanak, 'Show Me the Water Plan: Urban Water Management Plans and California's Water Supply Adequacy Laws', *Golden Gate University Environmental Law Journal*, 4.1 (2010).

[17] American Society of Civil Engineers.

[18] Matthew Heberger et al., 'The Impacts of Sea-Level Rise on the California Coast,' Pacific Institute, CEC-500-2009-024-F, 2009.

[19] David Senn et al., *Synthesis of Current Science: Influence of Nutrient Forms and Ratios on Phytoplankton Production and Community Composition* (Richmond, CA: San Francisco Estuary Institute, 2016).

[20] Diana Lin et al., *Contaminants of Emerging Concern in San Francisco Bay: A Strategy for Future Investigations 2018 Update* (Richmond, CA: San Francisco Estuary Institute, 2018).

ADVANCING WATER REUSE IN THE BAY AREA REQUIRES A REGIONAL APPROACH

San Francisco Bay (Pimlico27)

Water reuse is not solely an engineering problem that requires engineered solutions. To effectively advance water reuse, elected officials, members of the public, environmental advocates, public health experts, and other stakeholders must share a common vision. Developing a regional approach to water reuse will be essential for facilitating the necessary coordination among agencies, for taking advantage of site-specific opportunities, and for developing projects that can show a return on investment as well as access diverse funding streams. A regional approach provides a basis for advocates of the practice to better understand the true costs of water that are not currently being considered, including resiliency and environmental benefits, as well as help to establish a clear message and communicate in a unified voice.

Examples of additional specific ways in which a regional approach can help advance water reuse are explained below.

Coordination for water reuse

At some point in the not-so-distant future, wastewater in the Bay Area will likely become a limited commodity (i.e., project proponents will have plans for much or all of the effluent being produced). A regional approach to water reuse will enable strategic planning for how to allocate wastewater for reuse in ways that minimize cost, ensure social equity, and provide the most environmental benefit. Regional collaboration to determine appropriate metrics for assessing the multiple benefits of water reuse projects in the Bay Area will enable a shared framework for evaluating the success of water reuse projects. These metrics could include quantity of water supplied, costs, impacts on San Francisco Bay, resilience to changing environmental conditions, "greening" of implementing organization's reputation and level of social support.

Few utilities in the region encompass both water supply and wastewater treatment. For those utilities that manage both aspects of water, it is not always possible to transfer funds between departments. Many of the service area boundaries of Bay Area utilities are not conducive to optimal decision-making about water reuse (e.g., to enable reuse within a utility's service area, wastewater effluent might have to be pumped uphill or over long distances). Forging new organizational connections and reinforcing existing ones will be essential for the joint planning and partnership that are necessary to develop and maintain water reuse projects.

Although coordination among different branches of one utility that manage both water and wastewater can be difficult, effectively collaborating between different organizations can be even more challenging. Successful examples of inter-utility collaboration exist (see 'Learning from Local Experiences', p. 21), and can provide useful insights into how increased coordination and collaboration can occur.

Harmonizing planning for onsite and centralized water reuse projects is particularly important because a lack of coordination around new projects can result in inefficient use of funds and create water systems that are difficult to maintain. For example, in a city that has invested in infrastructure for centralized potable or non-potable water reuse, additional extensive development of graywater reuse or onsite reuse systems could result in the municipal system being oversized. Graywater reuse and onsite reuse can complement municipal systems in places where centralized water reuse is not feasible.

Sharing costs associated with development of water reuse infrastructure is another way in which regional collaboration can advance the practice. In addition, water reuse projects that extend beyond the purview of any one utility are sometimes more competitive for organizations seeking state and federal funding. By partnering through a regional collaborative process, stakeholders can collectively recognize and identify meaningful project metrics that can provide maximum economic, social, and environmental benefits.

Innovative regulatory mechanisms, like cap-and-trade for wastewater discharges in locations of the Bay where that is ecologically appropriate, may serve to spur regional coordination by encouraging exchange agreements between utilities.

Site-specific opportunities

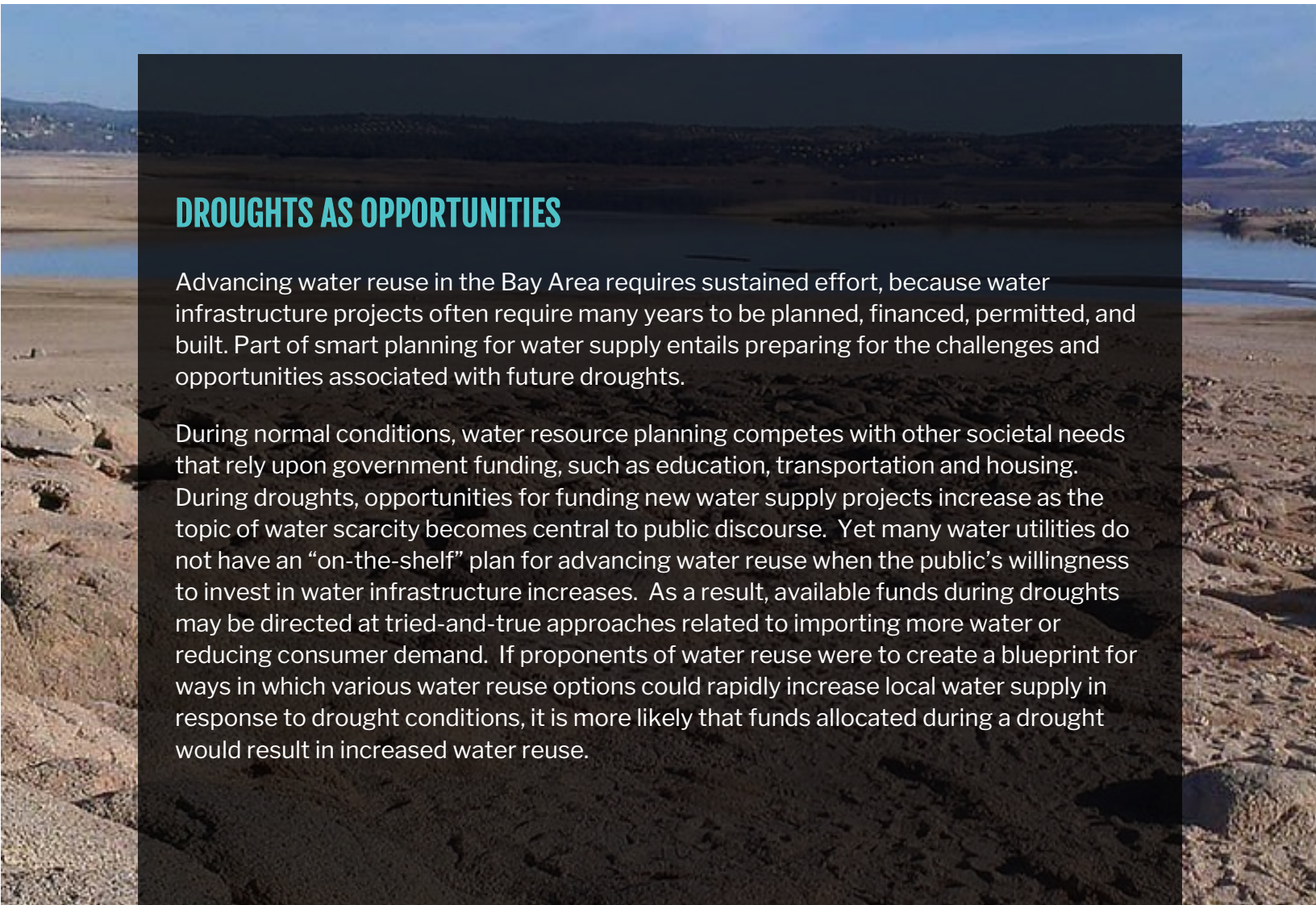
Collaboration within the Bay Area may provide a means for pooling resources to pilot new water reuse technologies and conduct applied research on issues of importance to the entire region (e.g., reverse osmosis concentrate treatment to avoid adverse effects on the San Francisco Bay). A regional approach can take advantage of site-specific opportunities for water reuse by optimizing appropriate projects for the local context. Successful demonstration projects can benefit the whole region by helping elected officials and members of the public gain familiarity with water reuse, by trailblazing regulatory pathways to innovative water reuse projects, and supporting research to fill data gaps.

Building from existing regional collaboration

The Bay Area Integrated Regional Water Management Plan (IRWMP) is an existing platform for coordinating regional water management.[21] The relationships among agencies and organizations that have been forged through the IRWMP process may provide a basis for strengthening regional collaboration to advance water reuse.

Bay Area Regional Reliability (BARR) is a partnership of water agencies in the Bay Area that are working together to improve regional water supply reliability. One of BARR's efforts has focused on creating interties between agencies' piped water supply networks in order to transfer water to places where it might be needed during a drought. Expanding BARR partnerships to include wastewater agencies and water recycling entities could leverage this existing platform for collaboration to advance water reuse.

[21] *San Francisco Bay Area Integrated Regional Water Management Plan*, 2013

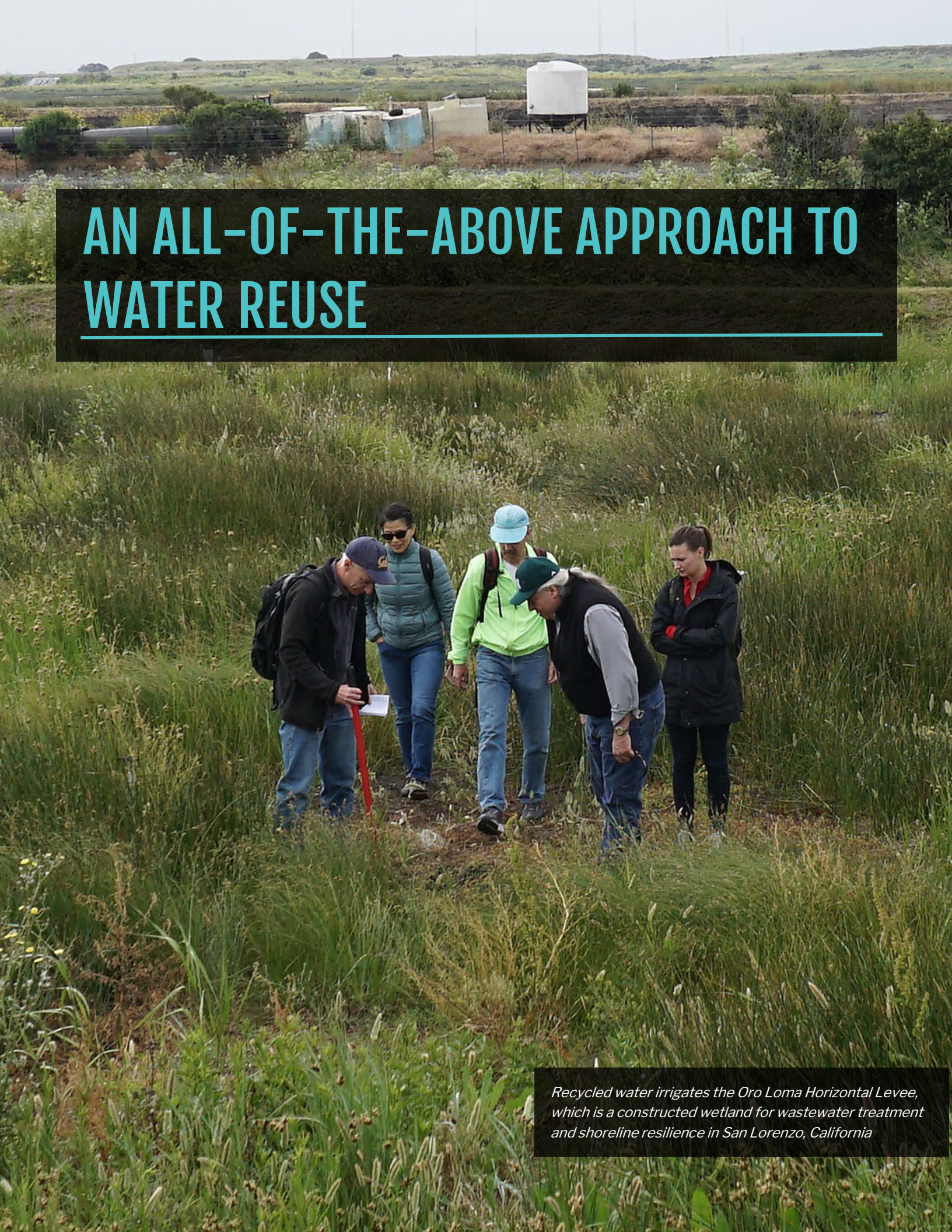


DROUGHTS AS OPPORTUNITIES

Advancing water reuse in the Bay Area requires sustained effort, because water infrastructure projects often require many years to be planned, financed, permitted, and built. Part of smart planning for water supply entails preparing for the challenges and opportunities associated with future droughts.

During normal conditions, water resource planning competes with other societal needs that rely upon government funding, such as education, transportation and housing. During droughts, opportunities for funding new water supply projects increase as the topic of water scarcity becomes central to public discourse. Yet many water utilities do not have an "on-the-shelf" plan for advancing water reuse when the public's willingness to invest in water infrastructure increases. As a result, available funds during droughts may be directed at tried-and-true approaches related to importing more water or reducing consumer demand. If proponents of water reuse were to create a blueprint for ways in which various water reuse options could rapidly increase local water supply in response to drought conditions, it is more likely that funds allocated during a drought would result in increased water reuse.

AN ALL-OF-THE-ABOVE APPROACH TO WATER REUSE



Recycled water irrigates the Oro Loma Horizontal Levee, which is a constructed wetland for wastewater treatment and shoreline resilience in San Lorenzo, California

Water reuse can come in many different forms, and it is unlikely that any single approach will dominate investment in the Bay Area. Instead, a mix of many different types of water reuse, including centralized non-potable reuse, onsite and community-scale non-potable reuse, household graywater use, and potable reuse will likely suit different local contexts, goals, and resources. This all-of-the-above strategy reflects the complexity of the Bay Area's water system as well as the diverse institutions involved to achieve integrated urban water management.

Centralized non-potable reuse

Historically, the majority of California's water reuse projects involved centralized, non-potable water reuse. Such systems have been used to irrigate golf courses, parks, schools, highway medians, sports fields, and to support farming in places like the Salinas Valley. When recycled water is used for irrigation (i.e., landscaping and specialty agricultural applications such as growing grapes), it is especially beneficial because the nutrients in the wastewater effluent are put to productive use (as fertilizer) and are not discharged directly to the San Francisco Bay. However, the prospect for increased non-potable centralized reuse is uncertain because it can be costly, and in some places infeasible to extend the recycled water distribution network to the places where the water is to be used.[22] An additional concern is that irrigation demand decreases in the winter but recycled water is produced year-round, resulting in inefficient use of assets. This discrepancy between supply costs and variable demand makes for a challenging business model for non-potable centralized water reuse systems. However, as the hidden costs of water are starting to be realized, cost increases to include added resiliency and environmental benefits may become more common.

Still, non-potable water reuse in centralized and onsite systems can be effective, and new opportunities for it may emerge. In the future, these systems may prove to be especially useful for projects that enhance shoreline resilience by irrigating horizontal levees, or by allowing cities to maintain green spaces. Existing non-potable water reuse systems are typically supplied by a single wastewater treatment plant and may only provide water to a modest number of local users. Regional collaboration and coordination may provide a basis for interconnecting pipe networks to distribute non-potable recycled water by taking advantage of existing networks along the shoreline. Such a network could create opportunities for expanding the user base for recycled water when demand for irrigation is lower (like cooling or industrial applications) and for sending recycled water to users who are not located close to a wastewater treatment plant.

There may be opportunities to use more non-potable recycled water for industrial purposes in the Bay Area in oil refineries and other water-using businesses located near wastewater treatment plants. Although such projects would offset the use of imported water for this purpose, it may not be compatible with the values of Bay Area residents who do not wish to subsidize or otherwise support the operations of oil companies. Making substantial investments of public resources in infrastructure that supports fossil fuel consumption also may be seen as incompatible with the State's effort to transition away from fossil fuels.

Governor Gavin Newsom:

"California's water challenges are daunting, from severely depleted groundwater basins to vulnerable infrastructure to unsafe drinking water in far too many communities. Climate change magnifies the risks. To meet these challenges, we need to harness the best in science, engineering and innovation to prepare for what's ahead and ensure long-term water resilience and ecosystem health. We'll need an all-of-above approach to get there."[23]

[22] Heather N. Bischel et al., 'Management Experiences and Trends for Water Reuse Implementation in Northern California', *Environmental Science & Technology*, 46.1 (2012), 180–88.

[23] "Governor Newsom Directs State Agencies to Prepare Water Resilience Portfolio for California," Press Release, Office of Governor Gavin Newsom, April 2019.

Onsite and community-scale non-potable reuse

Onsite and community-scale non-potable water reuse circumvent some of the problems associated with the scarcity of public funds to build water infrastructure by passing the costs onto the owners or developers of new projects. Private sector involvement means that new onsite water reuse projects can be built relatively quickly and without raising rates on the public at large. Irrespective of funding sources, smaller-scale non-potable water reuse projects may obviate the need to pump water over long distances and to maintain large water distribution networks.

Onsite reuse projects appeal to the desire of developers, elected officials and members of the public to support visible projects that are considered environmentally beneficial. Large buildings, campuses, and other developments may take advantage of onsite reuse opportunities to burnish their "green" reputation. Private sector investment in innovative onsite water reuse systems helps drive community and rate-payer support for sustainable water supply solutions. Onsite reuse systems can start broad discussions and spur enthusiasm among residents and employees about sustainable water supplies.

Onsite reuse is particularly relevant for water supply augmentation when it is located in places where existing recycled water distribution systems are not available. Coordination between local water utilities and private developers interested in onsite reuse can ensure efficient operation of both onsite and centralized reuse systems. Decentralized water infrastructure of this type can also provide resilience to natural hazards; for example, if an earthquake temporarily prevented the centralized water supply system from delivering water, a decentralized, onsite approach could provide a temporary supply. Onsite water systems can complement centralized infrastructure when existing water or wastewater systems are close to capacity.

Technologies for onsite water reuse exist and continue to mature. While onsite reuse systems are often more expensive with respect to the quantity of water produced than centralized potable and non-potable water supplies, they can be more practical in areas of planned growth or new development where expansion of centralized water or wastewater infrastructure would be cost prohibitive. Financial support for developers of onsite reuse to create more reliable, less expensive systems could help increase the rate of adoption of this practice. In addition, clear regulatory frameworks for designing and permitting onsite reuse, created through experiences with early adopters of the technology, will streamline future implementation of such projects.

The Salesforce Tower in San Francisco has one of the largest onsite blackwater recycling systems in the world (Scott Hess)

Even with widespread onsite reuse systems, centralized wastewater treatment usually is needed by other members of the community living adjacent to projects with onsite supplies. Onsite systems often require a connection to the municipal systems as a backup and as a means of disposing of wastes generated by the onsite reuse system. Open communication between the operators of centralized systems and onsite systems in a region is necessary to ensure that adoption of onsite reuse systems do not have unintended consequences (e.g., increasing costs for other users, overwhelming the capacity of sewers to process solids).

Graywater reuse

Household-scale use of wastewater from clothes washing machines and showers (i.e., graywater reuse) is a potential means of recycling water that is supported by many members of the public in the Bay Area. In addition to serving as a potentially inexpensive means of reusing water, graywater reuse can help change the mindset of perpetual water abundance that was common in California throughout much of the twentieth century. Furthermore, it can increase awareness and inform responsibility in what we consume and dispose of in our wastewater.

Currently graywater reuse is practiced on a relatively small scale in the Bay Area. If more city ordinances were to promote it, there could be unintended consequences; more understanding is needed about the ways in which graywater reuse on a watershed scale could affect public health as well as urban creeks, soils, and the ecology of the Bay. In addition, there is not a clear understanding of whether graywater reuse actually results in decreases in water demand, or if on the contrary it encourages additional water use for landscaping.[24]

Potable water reuse: groundwater recharge, surface water augmentation, and direct potable reuse

Using modern technologies, wastewater can be purified to drinking water standards. When this type of recycled water is used to recharge groundwater aquifers, fill reservoirs, or is piped directly to drinking water treatment plants, this is known as 'potable water reuse'. Potable water reuse is attracting a lot of attention and investment across California because it does not require construction of purple pipe networks and potable water demands are relatively consistent year-round. All existing potable water reuse projects in California involve recharging aquifers with recycled water, and projects that augment reservoirs with recycled water are on the horizon.

Below: Students examine a cutaway of a microfilter, one of the technologies used for treating recycled water to drinking water quality standards

Existing potable reuse projects in Southern California include one in Orange County, where a groundwater recharge project initiated about 50 years ago has advanced to a stage in which essentially all of the wastewater produced in the county is being used to recharge drinking water aquifers. These projects have established pathways to develop potable water reuse worldwide. WateReuse California and other groups have put substantial effort into smoothing the path for permitting of such projects in the past 15 years, first by lobbying for the finalization of regulations for permitting groundwater recharge projects and more recently by drafting and lobbying for regulations for surface water augmentation in California.

Potable reuse may play a role in the Bay Area's future water supply. Some parts of the Bay Area have suitable access to groundwater aquifers that could be recharged with recycled water, for example in the Livermore Valley and in Santa Clara County.[25] Reservoir augmentation with recycled water is another possibility, however, this approach may be limited in the Bay Area due to the lack of readily accessible reservoirs and the long pumping distances between recharge treatment plants and reservoirs that would increase cost. Research is needed to assess the capacity of local groundwater aquifers and the costs of reservoir augmentation.

Direct potable water reuse, in which wastewater is purified to drinking water standards, then piped directly into the drinking water distribution system or the intake of a drinking water treatment plant, may also be on the horizon for some parts of the Bay Area.

[24] National Academies of Sciences, Engineering, and Medicine, *Using Graywater and Stormwater to Enhance Local Water Supplies: An Assessment of Risks, Costs and Benefits* (Washington, D.C.: The National Academies Press, 2016).

[25] Geosyntec Consultants, *Harvest and Use, Infiltration and Evapotranspiration Feasibility/Infeasibility Criteria Report* (Menlo Park, California: Bay Area Stormwater Management Agencies Association, 2011).

Direct potable reuse has not yet been implemented in California, but the Texas Commission on Environmental Quality has approved a project in El Paso, Texas which will consist of a full-scale direct potable reuse facility where treated water will be introduced directly into the distribution system.

In California, permitting for direct potable water reuse is currently planned on a case-by-case basis, and water utilities face substantial uncertainty when planning these types of projects. An expert panel concluded it would be feasible for the State to develop regulations that would make direct potable reuse feasible and as protective of public health as existing water supplies.[26] The California State Water Resources Control Board has proposed a framework for regulating direct potable water reuse, but states that "key knowledge gaps and key research recommendations must be addressed before uniform water recycling criteria for [direct potable reuse] can be adopted."[27]

Potable water reuse may face challenges in the Bay Area due to a lack of familiarity with the practice in the region and recollection of public opposition to a planned potable reuse project in the Livermore Valley two decades ago. In terms of current local attitudes to potable water reuse, the Monterey One Water Project, which provides recycled water for potable purposes for people living on the Monterey Peninsula, may be important to gauging regional attitudes towards the practice. In the Santa Cruz area, water utilities have found potable water reuse to be a much more appealing option for stakeholders than seawater desalination. In Southern California, which has embraced potable water reuse alongside other new water supply options like desalination, extensive education and outreach, stakeholder involvement in planning, community trust building in the water utilities proposing potable reuse, and state-of-the-art technology were important elements in making potable reuse a legitimate water supply option.[28]

Consumptive and non-consumptive uses of recycled water

Although there are often distinctions made between potable and non-potable use of recycled water, it may also be useful to consider consumptive and non-consumptive uses. Consumptive uses (e.g., landscape irrigation) remove water from the system and eliminate the possibility of future water reuse. Non-consumptive uses of recycled water (i.e., anything that eventually drains into the sewer, including toilet flushing and water used in the house) remains available for future water reuse.

Water reuse can be a multi-benefit approach

Water reuse projects can be designed to provide multiple benefits, including water supply augmentation, diversion of pollutants from sensitive surface waters, and increased resilience of water supplies to drought and other natural hazards. These multiple benefits should be transparently acknowledged, and can be measured and modeled using an analytical technique called multi-criteria decision analysis.[29] For example, a project that involves the recycling of municipal wastewater for irrigation of horizontal levees or other restored shoreline wetlands would provide multiple benefits by diverting nutrients and contaminants of emerging concern from discharge into the Bay, enhancing coastal resilience to sea level rise, and improving wetland habitat.

Above: A local small business uses recycled water to clean homeowners' trash cans

[26] Expert Panel on the Feasibility of Developing Uniform Water Recycling Criteria for Direct Potable Reuse, 'Expert Panel Final Report: Evaluation of the Feasibility of Developing Uniform Water Recycling Criteria for Direct Potable Reuse.'

[27] State Water Resources Control Board, 'A Proposed Framework for Regulating Direct Potable Reuse in California', 2019.

[28] Sasha Harris-Lovett et al., 'Beyond User Acceptance: A Legitimacy Framework for Potable Water Reuse in California', *Environmental Science & Technology*, 49.13 (2015), 7552–61

[29] Sasha Harris-Lovett, Judit Lienert, and David Sedlak, 'A Mixed-Methods Approach to Strategic Planning for Multi-Benefit Regional Water Infrastructure', *Journal of Environmental Management*, 233 (2019), 218–37.

LEARNING FROM LOCAL EXPERIENCES

Onsite water reuse at the Facebook Campus, Menlo Park, supports 13 acres of roof gardens and gathering spaces.

Local experiences with water reuse provide insights into the importance of cross-organizational partnerships, the ways in which water reuse can be advanced by municipal water utilities that are able to dedicate staff time to overcoming permitting challenges, and the various drivers for and barriers to potable and non-potable water reuse in the region. They also illustrate ways in which advocates have navigated the challenges of developing water reuse projects in the region.

Many stakeholders are involved with water reuse in the Bay Area. Water and wastewater utilities, private developers, and municipal governments have all pursued water reuse projects. Advocates for the environment, affordable housing, business interests, climate resilience and environmental justice have interest in water reuse projects in the region but most have not yet dedicated substantial effort to the issue. Regulatory authorities including the San Francisco Bay Regional Water Quality Control Board and the EPA are supportive of water reuse and have communicated to stakeholders that they hold a philosophy of using and developing regulation to enable to people to "do the right thing." However, the details of how to implement an economic, socially equitable, and environmentally beneficial sustainable water supply remain elusive.

The following examples illustrate recent experiences with water reuse in the Bay Area.

Valley Water: the importance of long-term, regional partnerships

In late 2019, Valley Water finalized a 76-year agreement with Mountain View and Palo Alto to recycle the wastewater treated by the two cities' wastewater treatment plants. Motivated by the projected economic impacts of water supply shortfalls in the Valley Water's jurisdictional area, the utility searched for entities willing to provide them with wastewater. Valley Water sought a long-term agreement that would reduce the financial risk of making an investment in water reuse infrastructure. They plan to sell recycled water for non-potable purposes initially (via purple pipe distribution), but transition to potable reuse by 2028.

In the interest of helping secure a reliable water supply going forward, Valley Water also partnered with a coalition of diverse organizations, including Apple, the California Department of Water Resources, the City of Sunnyvale, and the California Water Service Company to fund the construction of a $17.5 million pipe to bring the recycled water to where it will be used for irrigation at the Apple Park campus. These developments illustrate the importance of collaboration between water and wastewater utilities while simultaneously enabling private companies and developers to access recycled water for new projects.

Students tour Valley Water's water treatment facility

Monterey One Water: necessity is the mother of invention

The Monterey Peninsula, including the agricultural Salinas Valley, is isolated from the state and federal water projects, so the only water available in the region comes from local sources. Throughout much of the twentieth century, the development of urban and agricultural water supplies led to saline intrusions to aquifers and decimated populations of fish that relied upon the region's rivers, including the Carmel River.

To protect the unique ecosystem that is dependent upon flows in the Carmel River, the State Water Resources Control Board enacted a cease-and-desist order on water withdrawals from the Carmel River in 2009. This presented a challenge to water suppliers in the region, who were given five years to find an alternative water supply. An existing regional recycling project in Monterey had established a connection between wastewater treatment plants and agricultural water users; the cease-and-desist order along with local opposition to desalination encouraged local water managers to take water reuse to the next level and develop a potable water reuse system.

Out of necessity, nine public entities came together to develop Pure Water Monterey, a comprehensive water reuse initiative that purifies 5 million gallons per day of municipal wastewater, agricultural wash water, agricultural drainage water, and urban stormwater runoff into potable water that is used to recharge the region's groundwater aquifer. This new water supply source will meet 1/3 of the potable water demand on the Monterey Peninsula.

Community leaders attend the October 4, 2019 dedication of the Pure Water Monterey water reuse system. This facility provides purified water for public supply. This is the first of its kind to utilize not just wastewater, but stormwater, food industry processing water, and irrigation drainage water for potable and non-potable reuse.

SFPUC: water utilities as community partners

San Francisco Public Utilities Commission (SFPUC) is an integrated utility that operates one of the Bay Area's most important imported water systems, two wastewater treatment plants and other infrastructure that provides the city with power and stormwater management. SFPUC is currently pursuing an array of innovative water projects including the development of building-scale onsite reuse, non-potable reuse to provide irrigation water, and the reuse of water pumped from drainage systems designed to dewater foundations of buildings. Of particular note is the utility's leadership in integrating decentralized systems for onsite reuse with centralized infrastructure. SFPUC engaged with elected officials and private developers to establish onsite reuse ito enhance the city's green image and partner with community members in efforts to make the city more sustainable.

Developing a new water supply can take a municipal agency 15-20 years, factoring in time for planning, fundraising, permitting, and construction. SFPUC has found that onsite reuse partnerships with private companies can shorten this project timeline and provide new water infrastructure that is funded by private enterprise (e.g., real estate developers). In deliberately striving to be a good "community partner," SFPUC has found ways to support and advance onsite reuse by developing streamlined regulations, guidebooks, and information on the practice. They have envisioned ways in which they can take advantage of all the City's water sources, for example by facilitating reuse of brewery water and by passing legislation to require that developments of 250,000 or more square feet install onsite reuse systems.[30]

[30] San Francisco Public Utilities Commission, 'Local Water Program', 2019

Facebook: developing a "green" reputation

At Facebook's Bayfront campus in Menlo Park, the company has pioneered an onsite water reuse system to offset water that is being used for irrigation. The system, which was planned at the height of a drought and built in 2019, will employ a membrane bioreactor coupled to reverse osmosis to provide water to irrigate the buildings' rooftop gardens. The project was motivated by the company's desire to improve its image after negative media attention focused on their 9-acre green roof, which included a large event lawn. During the last drought, journalists speculated on how much water was needed to keep the roof green and derided the company's water use practices. In response, when Facebook built a new building with a 4-acre green roof, the company decided to pursue an onsite reuse system to irrigate all the rooftop gardens and flush toilets. Facebook opted to build their own onsite reuse system rather than wait for the municipal purple pipe network to be extended to their campus by the local water utility, which was expected to take more than a decade. By constructing their own onsite system, Facebook was able to have more control over the completion timeline as the owner-occupier of the building.

Right: Facebook's non-potable reuse system comprises micro-screening, membrane bioreactors, reverse osmosis, and UV disinfection with chloramine and mineral adjustment. The system is designed for 16 million gallons/year for irrigation of 13 acres of rooftop gardens and gathering spaces. This is an example of distributed water reuse, which is gaining popularity at large tech campuses and office buildings in California.

SFPUC had laid the groundwork for onsite reuse projects in San Francisco, but there were no analogous examples on the Peninsula for Facebook to follow. Facebook built coalitions with advocates at the City of Menlo Park, the San Francisco Bay Regional Water Quality Control Board, and the Division of Drinking Water, among others. They embarked on a long and complicated permitting process to get their onsite reuse system running. Despite the regulatory hurdles, they were motivated to pursue the project because having an onsite reuse system helps create a culture of innovation and a sustainable workplace, which they believe attracts and retains the kind of workers Facebook wants to employ.

OPPORTUNITIES TO ADVANCE WATER REUSE IN THE BAY AREA

The Jeffrey G. Hansen Water Recycling Plant that provides irrigation water to large irrigation customers in Dublin, San Ramon and Pleasanton.

Advancing water reuse in the Bay Area depends upon addressing specific gaps and barriers in the region. At the December 2019 gathering, Bay Area One Water Network workshop participants identified specific opportunities for action to advance water reuse that address the region's particular needs. In the process of addressing these needs, relationships will be established among groups that can help advance the vision for water reuse described above.

Institutional actions

1. Find ways to share the risks and benefits of water reuse among various contributing organizations.
2. Create and implement a framework to coordinate development of onsite and community-scale reuse with centralized water reuse in the Bay Area.
3. Incentivize the creation of "virtual utilities" (i.e., water and wastewater agencies that work together on specific reuse projects) by implementing formal agreements establishing roles and responsibilities in a shared effort to implement water reuse projects.
4. Revitalize Integrated Regional Water Management planning groups by providing incentives for regional water reuse projects.
5. Develop a "hierarchy of uses" for recycled water in the Bay Area and use it to incentivize water recycling projects that are higher on the list.
6. Develop a "sewershed management" approach. "Sewershed management" entails strict control on the chemicals (particularly industrial chemicals) and other pollutants that may be discharged to water reuse projects to minimize risks to water quality in reuse projects.

Regulatory actions

1. Evaluate the impacts of regulatory drivers on water reuse in the Bay Area, including limits on wastewater effluent discharge volumes, limits on nutrient loads, and incentives for water reuse.
2. Assess the potential for a cap-and-trade approach to limiting wastewater discharge in San Francisco Bay.
3. Consider regulation to ensure that water reuse projects result in environmental benefits (i.e., reductions in the volume of water appropriated from sensitive rivers or aquifers).
4. Pair regulatory mandates relating to water reuse with funding to achieve them.
5. Streamline permitting and building codes for onsite water reuse around the Bay Area.
6. Refine and modernize non-potable water reuse requirements to accurately reflect current science on the safety of non-potable water reuse and to remove unintended disincentives to reuse.

Financial actions

1. Invest collectively in institutional capacity for collaboration at water and wastewater utilities to ensure equity across the region. For example, collective funding could enable resource-poor utilities to hire water reuse project managers to interface with other stakeholders.
2. Invest collectively in research to fill water reuse data gaps (see Appendix B for identified research and data needs).
3. Increase funding for water reuse projects through existing programs (e.g., the State's revolving fund) and the creation of incentives for innovative new projects.
4. Develop variable pricing schemes for non-potable recycled water to incentivize uses of recycled water in winter.

Technical actions

1. Conduct research and broadly communicate findings to fill data gaps about water reuse (see Appendix B for identified research and data needs).
2. Develop standard metrics to assess the multiple benefits of water reuse projects.

Communication actions

1. Standardize messaging around water reuse in a manner that builds legitimacy (e.g. through the use of positive language such as, “We installed an onsite treatment system to conserve water” instead of “Do not drink recycled water”).
2. Develop a common narrative about water reuse and its potential impacts in the Bay Area.

Municipal actions

1. Create institutional capacity for collaboration at water and wastewater agencies (i.e., have a One Water manager at each water and wastewater utility who can interface with others).
2. Develop water reuse projects that do not depend on a single user (i.e., golf courses and refineries), which could become stranded assets.
3. Embrace a culture of innovation while maintaining a focus on public health.
4. Track efforts to develop more resilient and sustainable water supplies.

Onsite and community-scale actions

1. Implement and publicize local demonstration projects.
2. Create location-specific recommendations for new developments that employ onsite reuse, so they are specifically sited in locations that are not near existing non-potable pipe networks, and where new projects will not adversely affect municipal wastewater and/or centralized water reuse plants.
3. Develop certification systems to standardize design and operation of onsite and community-scale reuse to ensure reliability and safety.

Purple pipes being installed to irrigate businesses and institutions in the San Ramon Valley Recycled Water program (Dublin, San Ramon and Pleasanton).

CONCLUSION

The Bay Area, like many regions around the world, is part of a changing paradigm that values a circular economy with an ethos of effectively recycling and stewarding natural resources, including water. Water reuse can fit into this worldview. Recycled water can be an important piece of resilient and diversified water supply portfolios in the Bay Area. Each community in the region has unique drivers, challenges, and opportunities associated with water reuse; regional collaboration can ensure collective benefit from pioneering projects and provide opportunities for pooled resources to support equitable development. It also can create new opportunities for cooperation in achieving shared goals. Research and development by universities and water professionals can fill existing knowledge gaps and inform regional decision-making.

Despite the potential opportunities associated with water reuse, many hurdles to advancing water reuse in the Bay Area remain. The set of opportunities generated by workshop participants and presented in this report serves as a starting point for focusing the discussion moving forward. Of particular note, increasing water reuse requires new ways of doing business. Water utilities must continue moving from a mindset of selling water to one of integrated water management, including resiliency, social equity, and environmental benefit. Various organizations and stakeholders that have not previously considered reuse as one of their responsibilities must forge partnerships that extend beyond traditional water and wastewater management jurisdictions. Development of regional visions for water reuse and transparent metrics for assessing the success of water reuse projects can ensure that the practice serves the needs and interests of the many different communities in the Bay Area.

APPENDIX A: Workshop Participants

Monitoring readouts from the Monterey One Water treatment facility (Monterey One Water)

Participants at the Bay Area One Water Network workshop on advancing water reuse in the San Francisco Bay Area, held in Berkeley, CA in Dec. 2019.

Hossein Ashktorab, Valley Water

Allison Brooks, Bay Area Regional Collaborative

Heather Cooley, Pacific Institute

Peter Drekmeier, Tuolumne Trust

Nahal Ghoghaie, Bay Conservation and Development Commission

Eric Hansen, Silicon Valley Clean Water

Ben Horenstein, Marin Municipal Water District

Eric Hough, Natural Systems Utilities

Linda Hu, East Bay Municipal Utility District

Paula Kehoe, San Francisco Public Utilities Commission

Melody LaBella, Central Contra Costa Sanitary District

Amelia Luna, Sherwood Engineers

Richard Luthy, Stanford University

Felicia Marcus, Water Policy Group

Azalea Mitch, City of San Mateo

Steve Moore, Ross Valley Sanitary District

Melanie Mow Schumacher, Soquel Creek Water District

Tom Mumley, San Francisco Bay Regional Water Quality Control Board

Dennis Murphy, Sustainable Silicon Valley

Kara Nelson, UC Berkeley

Karin North, City of Palo Alto

Eric Rosenblum, Envirospectives

Paul Sciuto, Monterey One Water

David Sedlak, UC Berkeley

Dave Smith, US Environmental Protection Agency

Sue Stephenson, Dublin-San Ramon Services District

Lauren Swezey, Facebook

Laura Tam, SPUR

Luisa Valiela, US Environmental Protection Agency

Jackie Zipkin, East Bay Dischargers Authority

Workshop support provided by:

Kara Baker, ReNUWIt

Taylor Chang, San Francisco Public Utilities Commission

Miriam Hacker, Eawag

Sasha Harris-Lovett, Berkeley Water Center

Molly Mayo, Meridian Institute

Brad Spangler, Meridian Institute

APPENDIX B: Data and Research Needs

Full advanced water treatment

Data gaps and research needs for advancing water reuse in the Bay Area

Technical

1. Develop cost-effective technologies to treat reverse-osmosis concentrate prior to its discharge to the San Francisco Bay.
2. Develop onsite reuse engineering standards that can be more widely practiced.
3. Assess the effects of widespread graywater use for landscaping on soil health and water quality on a local and regional scale.
4. Develop cost-effective technologies that can improve the quality of graywater produced at the household scale.

Health

1. Improve knowledge of the potential health risks associated with exposure to recycled water as a drinking water supply (including acute risk of pathogen exposure, long-term risk of chemical exposure, and the potential for increasing populations of antibiotic resistant bacteria).
2. Improve knowledge of the potential health risks associated with non-potable reuse, including pathogen exposure when recycled water is used in buildings for air conditioning and in agriculture for sub-surface drip irrigation.

Logistical

1. Create a model to evaluate regional water reuse options under current and projected future conditions (e.g., in 2050), including water supplies, wastewater treatment, siting of existing infrastructure, and population growth.
2. Assess the costs and benefits of exporting recycled water to the Central Valley or Salinas Valley for irrigation.
3. Assess ways in which reverse-osmosis concentrate could be managed regionally to discharge in deeper water outfalls and avoid discharge in sensitive shallow habitats.
4. Model the impacts of onsite and community-scale reuse systems on the costs of operating and maintaining centralized wastewater treatment infrastructure in the Bay Area.
5. Model the extent to which water from reuse projects (e.g., Title 22 recycled water or RO concentrate) could be used to support horizontal levees in the Bay Area, given spatial (and other) constraints.
6. Model energy requirements of different reuse scenarios for the region relative to current water supply options and other approaches.

7. Evaluate the cost, siting, and logistics of a "blue loop" pipe of recycled water around the Bay that different users could tap into.
8. Identify utility business models for operating community-scale (satellite) non-potable water reuse systems.
9. Model ways in which non-potable water reuse could benefit greening (tree planting, urban forest) projects to reduce the urban heat-island effect.
10. Assess the potential for and costs of distributed urban recycled water storage in the Bay Area (i.e., cisterns under parks).

Communications

1. Identify metrics for success of water reuse projects.
2. Assess ways in which existing communications about water reuse projects reflect these metrics for success.

Institutional

1. Assess opportunities for partnership between utilities to support water reuse.
2. Develop best-practices for designing water reuse infrastructure for flexible future use (i.e., "future proofing"), at utilities and onsite.
3. Assess the institutional capacity for water reuse projects across the region and develop recommendations for increasing access and capacity within low-income communities.
4. Model the effects of potential regulatory drivers for reuse across the region (i.e., SB 332 for reducing wastewater discharge, requiring the use of non-potable water for specific purposes like large-scale irrigation, requiring onsite non-potable reuse for developments of a certain size, requiring purple pipe systems for developments of a certain size, requiring "cap and trade" of wastewater discharges).
5. Identify analogies between decentralized energy and water systems, and determine ways in which historical social/political/institutional support for decentralized energy can apply to water systems.
6. Assess funding models for the centralized water and wastewater systems that manage a service area that includes onsite reuse systems and help support onsite reuse operations by helping dispose of their waste.
7. Assess ways in which water reuse legislation would affect the cost of housing in the Bay Area.

(Monterey One Water)