# An Assessment of Urban Water Demand Forecasts in California

Sonali Abraham, Sarah Diringer, and Heather Cooley

PACIFIC INSTITUTE

August 2020

# An Assessment of Urban Water Demand Forecasts in California

August 2020

**Authors**
Sonali Abraham
Sarah Diringer
Heather Cooley


**Pacific Institute**
654 13th Street
Preservation Park
Oakland, California 94612
510.251.1600 | info@pacinst.org
www.pacinst.org

Suggested citation for *An Assessment of Urban Water Demand Forecasts in California :*

Abraham, Sonali, Sarah Diringer, and Heather Cooley. 2020. *An Assessment of Urban Water Demand Forecasts in California*. Oakland, Calif.: Pacific Institute.

ISBN: 978-1-940148-08-3


Cover Photo Source: Courtney K., iStockPhoto | Designer: Bryan Kring, Kring Design Studio

## ABOUT THE PACIFIC INSTITUTE

The Pacific Institute envisions a world in which society, the economy, and the environment have the water they need to thrive now and in the future. In pursuit of this vision, the Institute creates and advances solutions to the world's most pressing water challenges, such as unsustainable water management and use; climate change; environmental degradation; food, fiber, and energy production for a growing population; and lack of access to freshwater and sanitation. Since 1987, the Pacific Institute has cut across traditional areas of study and actively collaborated with a diverse set of stakeholders, including policymakers, scientists, corporate leaders, international organizations such as the United Nations, advocacy groups, and local communities. This interdisciplinary and nonpartisan approach helps bring diverse interests together to forge effective real-world solutions. Since 2009, the Pacific Institute has also acted as co-secretariat for the UN Global Compact CEO Water Mandate, a global commitment platform that mobilizes a critical mass of business leaders to address global water challenges through corporate water stewardship.

More information about the Pacific Institute and our staff, directors, and funders can be found at www.pacinst.org.

## ABOUT THE AUTHORS

### SONALI ABRAHAM

Sonali Abraham is a Research Associate at the Pacific Institute. Sonali is currently pursuing a doctorate in Environmental Science and Engineering at the University of California, Los Angeles, where she conducts research on strategies to improve water resource sustainability with a focus on outdoor urban water efficiency. Sonali holds a Bachelor of Science in Chemistry from St. Stephen's College in New Delhi, India and a Master of Science in Environmental Engineering from Johns Hopkins University.

### SARAH DIRINGER

Dr. Sarah Diringer is a Senior Researcher at the Pacific Institute, where her work focuses on long-range water supply planning and sustainable water systems. Sarah has conducted research both domestically and abroad on watershed management and environmental health. Prior to joining the Institute, Sarah was a doctoral researcher at Duke University, conducting field work and lab research focused on the environmental and community impacts of mercury released from artisanal and small-scale gold mining in Peru. Sarah holds a Bachelor of Science in Environmental Science from the University of California, Los Angeles and a doctorate in Civil and Environmental Engineering from Duke University.

### HEATHER COOLEY

Heather Cooley is Director of Research at the Pacific Institute. Heather holds a Bachelor of Science in Molecular Environmental Biology and a Master of Science in Energy and Resources and from the

University of California, Berkeley. She received the US Environmental Protection Agency's Award for Outstanding Achievement for her work on agricultural water conservation and efficiency and has testified before the US Congress on the impacts of climate change on agriculture and innovative approaches to solving water problems in the Sacramento-San Joaquin Delta. Heather has served on several state task forces and working groups, including the California Commercial, Industrial, and Institutional Task Force and the California Urban Stakeholder Committee, as well as the board of the California Urban Water Conservation Council.

## ACKNOWLEDGEMENTS

We would like to thank all those who provided their time and data, including staff at the California Department of Water Resources, the City of Fresno, the City of Long Beach, and San Jose Water Company. We would also like to thank all those who offered ideas and comments on the report, including Martha Davis, Charlotte Ely (State Water Resources Control Board), Maureen Hodgins (Water Research Foundation), Cynthia Koehler (WaterNow Alliance), and Bob Wilkinson (University of California at Santa Barbara). Finally, we would like to thank the Water Foundation and the Water Efficiency Trust for generously supporting this work. All errors and opinions are, of course, our own.

# Contents



## FIGURES



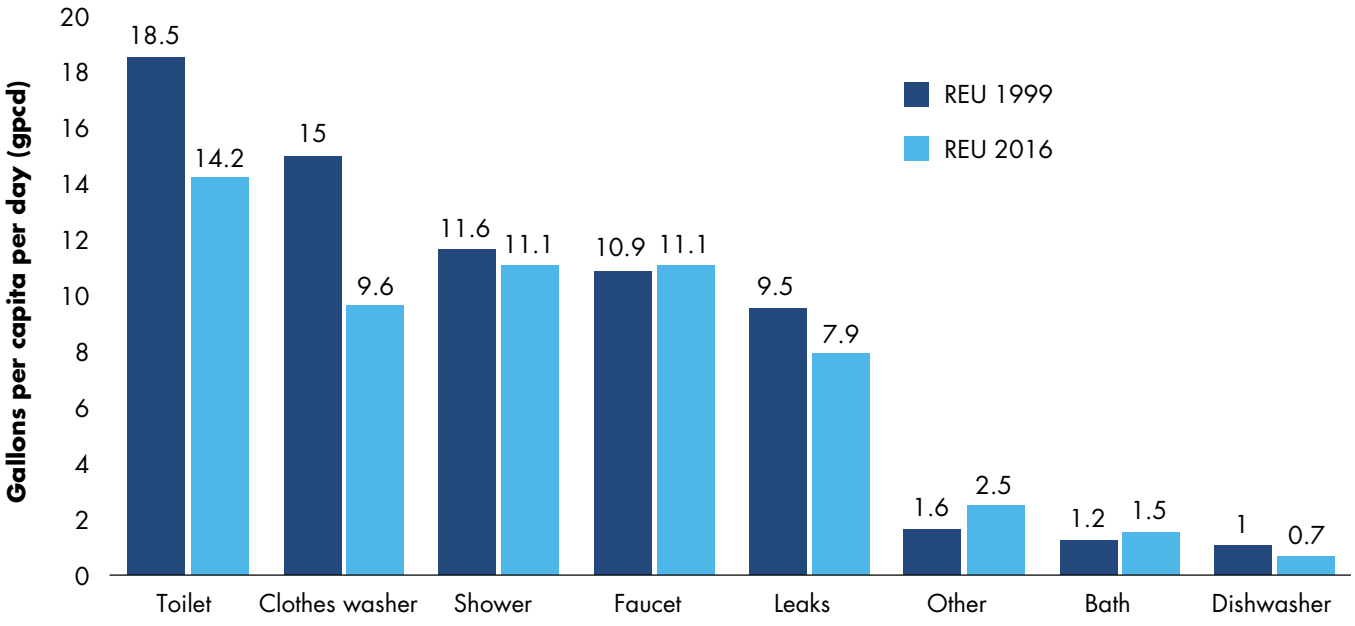
## TABLES

## INTRODUCTION

Water demand in urban areas changes over time in response to a variety of factors, including population, economic activity, demographics, weather, and the implementation of conservation and efficiency measures. In California, urban per capita water demand has declined dramatically over the past several decades (Cooley 2020). Several studies have demonstrated that greater uptake of water-efficient devices, primarily in the residential sector, has been a key driver in reducing per capita water demand. For example, DeOreo et al. (2016) demonstrated that market penetration of high-efficiency clothes washers between 1998 and 2015 accounted for the largest reduction in per capita water use, from 15.0 to 9.6 gallons per capita per day (gpcd), followed by toilets, from 18.5 to 14.2 gpcd (Figure 1). Fewer studies have examined the non-residential sector, but there is an indication that efficient devices are playing a role in reducing water usage there as well (e.g., Frost et al. 2016).

Reductions in per capita demand have important implications for estimating future water demand. Water utilities develop long-range water-demand forecasts to inform capital planning and major financial expenditures, such as investments in additional water supplies and treatment facilities (Billings and Jones 2008). Previous studies suggest that water suppliers routinely overestimate future

**Figure 1.** **Per Capita Residential Water Demand Between 1998 and 2015, as Described by the Residential End Uses of Water Studies in 1999 and 2016**




*Source:* DeOreo et al. 2016

water demand due, in part, to a failure to account for the long-term trend of declining per capita water demand (e.g., Heberger, Donnelly, and Cooley 2016; Diringer et al. 2018). This can lead to unnecessary and costly investment in unneeded infrastructure and new sources of supply, increased water utility bills, and adverse impacts on water quality and local economies.

In this report, we examine the accuracy of long-range demand forecasts for California's 10 largest urban water suppliers using data and information provided by each water supplier in their Urban Water Management Plans (UWMPs). In 2015, these 10 suppliers served 25 percent of the state's population. We found that per capita water demand declined for all water suppliers between 2000 and 2015. In most cases, reductions in per capita water demand were so large that total water demand declined during this period. Further, we found that all water suppliers overestimated demand. This was largely driven by inflated estimates of per capita water demand, although overestimates of population growth were also factors. On average, water suppliers projected that per capita demand would decline by less than one percent per year; actual per capita demand declined twice as fast. Greater effort is needed to improve the accuracy of long-range demand forecasts, and we offer recommendations for these improvements.

## METHODS

For this assessment, we evaluated water demand forecasts submitted by urban water suppliers in their Urban Water Management Plans (UWMPs). In California, water suppliers that provide more than 3,000 acre-feet of water annually or serve more than 3,000 customers (referred to as urban water suppliers) are required to prepare a UWMP every five years and submit those plans to the California Department of Water Resources (DWR). The first UWMPs were published in 1990, and the most recent plans provide data and information for the year 2015.[1] The UWMPs contain past and projected future water demand for the supplier's service area. While utilities may develop and publish demand forecasts in other documents, the projections in the UWMPs allow for a consistent evaluation across California's urban water suppliers.

Historically, data and information from UWMPs were only available as individual portable document format (pdf) files. Given that there are more than 400 urban water suppliers in California, this has made it difficult to evaluate regional and statewide trends. Beginning in 2015, key data from the UWMPs were aggregated and made available electronically, which will make it easier to conduct these assessments in the future. Given our interest in evaluating pre-2015 UWMPs and the limited data available, we evaluated actual and projected water demand for the 10 largest urban water suppliers in California (Table 1). In 2015, these suppliers provided water to a total of nearly 11 million Californians, or about 25 percent of the state's population. Given their size and available resources, we would expect that their demand forecasts would be among the most sophisticated in the state. Future work should assess demand forecasts for small and mid-sized water suppliers.

For this analysis, we rely on data and information from four UWMPs (2000, 2005, 2010, and 2015) for each of the 10 urban water suppliers. While the UWMPs for 2005, 2010, and 2015 were available online, we received UWMPs for each of the 10 water suppliers for the year 2000 through a public

1 UWMPs for 2020 are under development and will be submitted to DWR in 2021.

records request.[2] We were unable to obtain UWMPs for 1990 and 1995 for all suppliers, and therefore excluded those years from this assessment.

**Table 1. Ten Selected Urban Water Suppliers and their Populations in 2015**

| Water Supplier | 2015 Population |
|---|---|
| East Bay Municipal Utilities District | 1,390,000 |
| Eastern Municipal Water District | 540,895 |
| City of Fresno | 520,159 |
| Irvine Ranch Water District | 387,501 |
| City of Long Beach | 483,371 |
| Los Angeles Department of Water and Power | 4,008,954 |
| City of Sacramento | 480,155 |
| City of San Diego | 1,314,290 |
| San Francisco Public Utilities Commission | 846,601 |
| San Jose Water Company | 990,000 |
| **Total** | **10,961,926** |

*Source*: Conservation Portal, State Water Resources Control Board

We extracted data from UWMPs for current and projected population and demand for potable, raw, and recycled water (Table 2). Each UWMP contained water demand projections for at least the subsequent 20-year period in five-year increments. We found that water demand is reported inconsistently in the UWMPs.

For example, some include the use of recycled water in their estimates of actual demand, others report it in a separate table, and for some, it is unclear how it is reported. Likewise, some report water losses, and others do not. Moreover, the categories reported have changed over time. For each supplier, we carefully selected end-use categories that were consistently reported across each of the UWMPs. Data reporting is improving, but additional effort is needed to clarify definitions and ensure consistent reporting across water suppliers and over time.

“

Data reporting is improving, but additional effort is needed to clarify definitions and ensure consistent reporting across water suppliers and over time.

**Table 2. Data Collected from Urban Water Management Plans**

| Category | Data Collected |
|---|---|
| Service Area | Current population |
| | Population projections |
| Water Demand | Current total demand, summed across consistent end-use categories as applicable |
| | Total demand projections, summed across consistent end-use categories as applicable |
| Recycled Water | Current recycled water demand, summed across consistent end-use categories as applicable |
| | Recycled water demand projections, summed across consistent end-use categories as applicable |

*Note:* In some cases, the total water demand reported in the UWMPs only included demand for potable water, and the use of recycled water was accounted for in a separate table. We included recycled water in both the actual and projected water demand and took every effort to avoid double counting it.

*Source*: Based on information contained in UWMPs submitted to DWR by each water supplier in 2000, 2005, 2010, and 2015

2 UWMPs for 2005, 2010, and 2015 can be found online at https://wuedata.water.ca.gov/.

## KEY FINDINGS

### TOTAL AND PER CAPITA WATER USE

All water suppliers experienced dramatic reductions in per capita demand between 2000 and 2015, ranging from 14 percent to 47 percent. During this period, per capita demand declined by an average of 25 percent across all water suppliers (Table 3). For eight of the 10 suppliers, per capita demand peaked in 2000 and declined in every subsequent five-year period. For the remaining two suppliers, per capita demand peaked for one in 2005 and the other in 2010 and declined thereafter.

For most water suppliers, the reduction in per capita water demand was substantial enough to offset population growth such that total demand declined. Between 2000 and 2015, total demand declined by an average of 18 percent across all water suppliers. During this period, total demand declined for nine of the 10 water suppliers despite continued population growth (Table 3). Despite large reductions in per capita demand, Eastern Municipal Water District experienced an 84 percent increase in population and was the only water supplier whose water demand increased during this period.

“

For most water suppliers, the reduction in per capita water demand was substantial enough to offset population growth such that total demand declined.

**Table 3. Percent Change in Total Demand, Per Capita Demand, and Population Between 2000 and 2015**

| Water Supplier | Per Capita Demand | Population | Total Demand |
|---|---|---|---|
| East Bay Municipal Utilities District | -17% | 9% | -9% |
| Eastern Municipal Water District | -39% | 84% | 12% |
| City of Fresno* | -22% | 11% | -14% |
| Irvine Ranch Water District | -33% | 43% | -3% |
| City of Long Beach | -25% | 4% | -22% |
| Los Angeles Department of Water and Power | -25% | 4% | -22% |
| City of Sacramento | -47% | 18% | -38% |
| City of San Diego | -16% | 3% | -14% |
| San Francisco Public Utilities Commission | -30% | 8% | -25% |
| San Jose Water Company | -31% | 1% | -30% |
| All Water Suppliers | -25% | 9% | -18% |

*Note:* The UWMP for the year 2000 was not available for the City of Fresno. The values here are therefore calculated as the change between 2005 and 2015. The per capita change across all suppliers was calculated accounting for population differences.

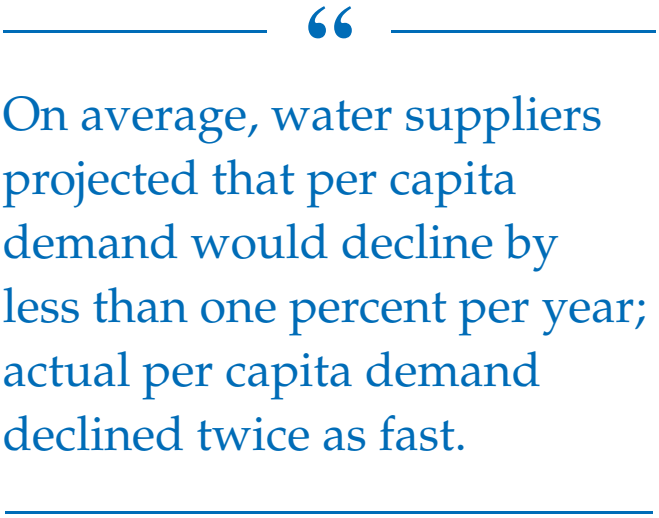
*Source*: Based on data provided in UWMPs submitted to DWR by each water supplier for 2000 and 2015

Statewide data are not yet available to evaluate water use since the most recent drought ended. However, monthly reports to the California State Water Resources Control Board (State Water Board) suggest that urban water use increased slightly after the drought ended but remains lower than before the drought.

## FUTURE DEMAND

For all of the water suppliers examined, the demand forecasts dramatically overestimated future water demand. Figure 2 shows actual and projected water demand for each of the 10 urban water suppliers. For this analysis, we examined a total of 39 UWMPs: four UWMPs for nine suppliers and three UWMPs for one supplier.[3] Each UWMP contained four to six estimates of future demand, although some earlier UWMPs did not include demand projections.[4] This resulted in a total of 177 data points. We found that the forecasts overestimated demand in 98 percent of the cases examined. The projections in UWMPs for the years 2000, 2005, and 2010 overestimated actual demand by 23 percent, 26 percent, and 26 percent, respectively. For nine of the 10 water suppliers, the overestimates were so large that their future water demand was projected to rise while actual water demand declined.

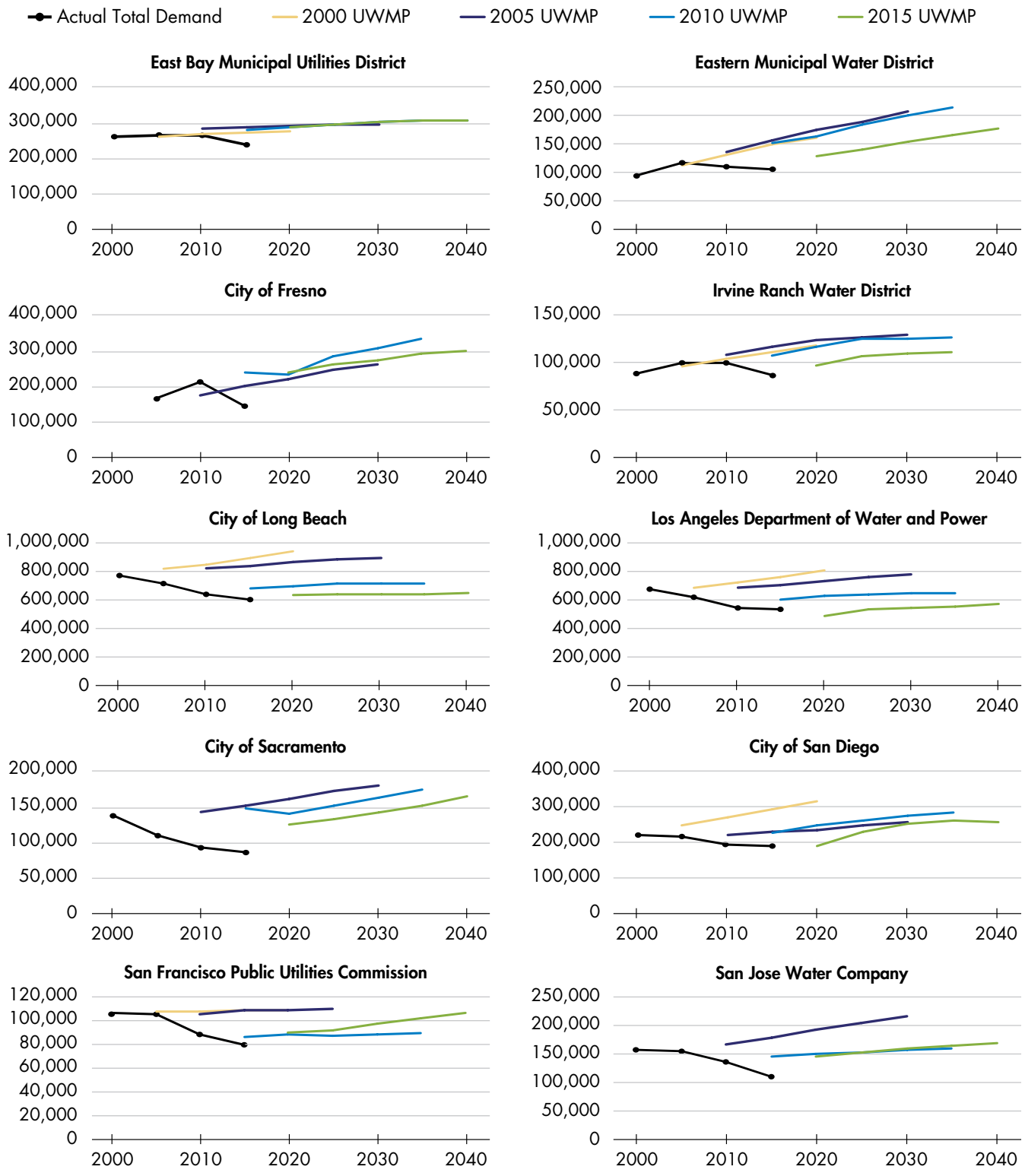
Future demand was overestimated largely due to inflated estimates of per capita demand. While the UWMPs provide insufficient detail on all the factors contributing to such large overestimates of demand, several inferences can be drawn for the information provided. For example, we find that population was overestimated in 80 percent of the cases examined; across all suppliers, population was overestimated by an average of five percent. While this contributed to overestimates of future demand, we find that the difference between actual and projected per capita demand was a much larger factor. Some water suppliers projected per capita demand would increase, whereas others projected it would remain flat or decline modestly (Figure 3). On average, water suppliers projected that per capita demand would decline by less than one percent per year; actual per capita demand declined twice as fast.




3 The 2000 UWMP was not available for the City of Fresno.

4 The City of Sacramento and San Jose Water Company did not provide total demand projections in their 2000 UWMPs. The City of Sacramento provided five demand estimates (2020, 2025, 2030, 2035, and 2040) in their 2015 UWMP.

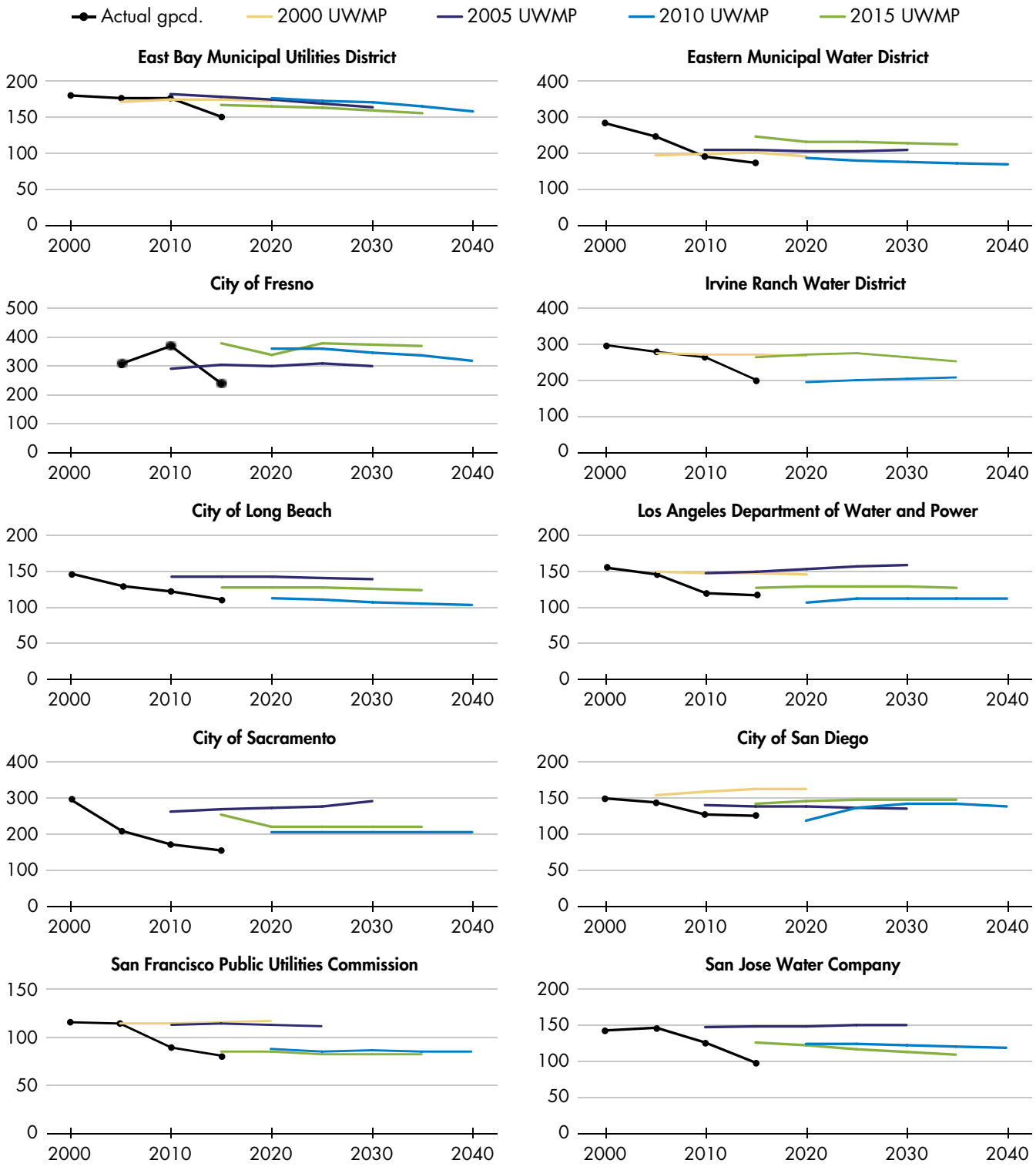
**Figure 2. Actual and Projected Total Demand Trends for the Ten Selected Water Suppliers (in Acre-Feet)**




*Source:* Urban Water Management Plans, DWR, 2000-2015

*Note:* The 2000 UWMP was not available for the City of Fresno; the 2000 UWMPs for the City of Sacramento and San Jose Water Company did not contain total demand projections.

**Figure 3. Actual and Projected per Capita Trends for the Ten Selected Water Suppliers (in Gallons per Capita per Day)**




*Source:* Urban Water Management Plans, DWR, 2000-2015

*Note:* The 2000 UWMP was not available for the City of Fresno; the 2000 UWMPs for the City of Sacramento and San Jose Water Company did not contain total demand projections; the 2000 UWMP for the City of Long Beach did not contain population projections; the 2005 UWMP for Irvine Ranch Water District did not contain population projections.

## CONCLUSIONS AND RECOMMENDATIONS

Over the last two decades, urban water demand in California has changed dramatically. For many urban water suppliers, total water demand has declined despite continued population and economic growth. Even for the one supplier whose demand increased, the increase was far less than anticipated. Moreover, for each of the 10 agencies examined, actual per capita water use was far below UWMP estimates. Unfortunately, long-range demand forecasting has been slow to keep pace with these trends. Urban water suppliers routinely overestimated future water demand, projecting increases in water demand even as actual demand declined. The is largely due to inflated estimates of future per capita demand, although overestimates of population are also a contributing factor. Overestimates of future water demands have important implications for local communities and the state. Specifically, they can result in unneeded water supply and treatment infrastructure, higher costs to ratepayers, and unnecessary adverse environmental impacts. We offer three recommendations to improve long-range demand forecasts.

### EVALUATE WATER USE TRENDS AND THE ACCURACY OF DEMAND FORECASTS

California's largest urban water suppliers consistently overestimate future water demand. Through interviews with water experts and practitioners, Diringer et al. (2018) found that water suppliers and consultants regularly update the input data for their forecasts but do not typically examine the underlying assumptions and the degree to which projections match actual demand. Rather than simply updating input data, forecasters should examine the underlying trends, assumptions within the models, and accuracy of past projections.

### DEVELOP STANDARDS AND GUIDELINES FOR URBAN WATER DEMAND FORECASTS

The state should convene stakeholders—including the Department of Water Resources, State Water Board, Strategic Growth Council, California Energy Commission, land use planning agencies, water utilities, data specialists, and non-governmental organizations—to develop standards and guidelines for improving the accuracy of urban water demand forecasts. One key issue that needs to be addressed is how to adequately incorporate efficiency improvements, denser developments, economic changes, and uncertainty into forecasts. Standards and guidelines are also needed for integrating climate change into these forecasts, as temperatures can have a major influence on water demand, especially in regions with high outdoor use. Finally, the state should require retail and wholesale water suppliers to include regular assessments of the accuracy of past demand forecasts in their urban water management plans.

### ADVANCE TOOLS AND RESOURCES FOR SMALL AND MEDIUM-SIZED WATER SUPPLIERS

This research focused on demand forecasts from the largest water suppliers in the state. Additional work is needed to evaluate demand forecasts for small and medium-sized water suppliers. These communities may be growing faster and could see even bigger reductions in per capita demand. If, as was found in this paper, demand forecasts assume that future per capita demand remains unchanged, then overestimates may be even larger. Moreover, smaller communities typically have fewer resources to invest in developing demand forecasts.

# References

Billings, R. Bruce, and Clive Vaughan Jones. 2008. *Forecasting Urban Water Demand. 2nd ed*. Denver, Colorado: American Water Works Association.

Cooley, Heather. 2020. *Urban and Agricultural Water Use in California, 1960-2015*. Oakland, Calif.: Pacific Institute. https://pacinst.org/wp-content/uploads/2020/06/PI_Water_Use_Trends_June_2020.pdf

DeOreo, William B., Peter Mayer, Benedykt Dziegielewski, Jack Kiefer. 2016. *Residential End Uses of Water, Version 2*. Water Research Foundation.

Diringer, Sarah E., Heather Cooley, Matthew Heberger, Rapichan Phurisamban, Andrea Turner, John McKibbin, and Mary Ann Dickinson. 2018. *Integrating Water Efficiency Standards and Codes into Long-Term Demand Forecasting*. Water Research Foundation.

Donnelly, Kristina and Heather Cooley. 2015. *Water Use Trends in the United States*. Oakland, Calif: Pacific Institute. http://pacinst.org/publication/water-use-trends-in-the-united-states/.

Frost, Douglas, Darren Sversvold, Eddie Wilcut, and David J. Keen. 2016. "Seven Lessons Learned Studying Phoenix Commercial, Industrial, and Institutional Water Use." *Journal of the American Water Works Association* 108 (3).

Heberger, Matthew, Kristina Donnelly, and Heather Cooley. 2016. *A Community Guide for Evaluating Future Urban Water Demand*. Oakland, Calif: Pacific Institute. http://pacinst.org/app/uploads/2016/08/A-Community-Guide-for-Evaluating-Future-Urban-Water-Demand-1.pdf.


**Pacific Institute**
654 13th Street
Preservation Park
Oakland, California 94612
510.251.1600 | info@pacinst.org
www.pacinst.org

ISBN: 978-1-940148-08-3