THE ECONOMIC VALUE OF EFFICIENCY FOR CALIFORNIA WATER SERVICE: LOWER WATER BILLS

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Executive Summary

Prior to about 2008-09, California Water Service Company (Cal Water) did not meter all its water customers, did not have conservation rates, and did not offer a robust set of conservation programs. Per capita water use had been flat or increasing prior to this period. In 2009, Cal Water adopted conservation rate designs (increasing block rates, IBRs), a more than three-fold increase in conservation program expenditure, and an accelerated schedule to convert unmetered customers to metered water service. Per capita water demand has decreased steadily since 2009. These innovative strategies related to water efficiency, conservation, and rates over the years pose the questions:

- "What would the economic impact on bills have been if none of these activities occurred?"
- "Are bill paying customers better or worse off because of these changes?"

The relationship between conservation and water rates is not always well understood. Many water professionals and customers are perplexed by rate increases when system-wide water use has gone down, and blame water conservation and efficiency as the culprit for higher rates.

This report provides evidence that this causality needs to be reversed: Higher water rates in a tiered structure send an intentional price signal to customers about the cost consequences of consumptive choices. Water rates that communicate cost consequences to customers provide the information basis for informed choices about efficient water use. Implementation of conservation water rates, universal metering, efficient plumbing standards, and long-term conservation programs have lowered utility operating costs in the short and long term. This ultimately lowers the cost burden on water customers. This Report explores this dynamic by evaluating the costs that have been avoided by Cal Water's water efficiency efforts, and the impact this has had on customer bills.

Specifically, this report provides a technical estimation of the economic benefit of conservation efforts over a more than a decade period by using avoided marginal costs of water service to value the savings. Historical roots of this analysis can be found in the benefit evaluation of public investments (Dupuit, 1844) and the institutionalist literature on avoided costs and efficient utility pricing (Boiteux, 1949).

This study assesses the customer benefit of Cal Water efficiency investments in five of its service areas: Bakersfield, Chico, East Los Angeles, Selma, and South San Francisco. These service areas were selected for the study because they span the diversity within Cal Water's districts in terms of geography, climate, supply sources, and socio-demographics. This study compares a constant per capita water demand—that is, a world absent of demand reductions—to the actual per capita demand that does embed demand reductions. It quantifies the additional operating expenses and capital expenditures that would have been needed to meet the higher level of constant per capita demand. Thus, the analysis compared historical operating costs for the period 2010-2019 to what those costs would have been in the absence of the reductions in per capita water demand that began around 2008-09. The results of the analysis are summarized in Table ES-1.

Table ES-1 Results: Estimated Percentage Reduction in Customer Bills

Service Area	Estimated 2010-19 Cumulative Operating Costs w/o Conservation (Mil 2019 $)	Actual 2010-19 Cumulative Operating Costs (Mil 2019 $)	Percent Bill Reduction due to Conservation, 2010-2019
Bakersfield	813.9	788.0	-3.2%
Chico	249.5	240.9	-3.4%
Selma	58.0	54.5	-6.0%
East Los Angeles	447.9	359.0	-19.9%
South San Francisco	275.8	234.5	-15.0%

Our modeling indicates that lower per capita water demand over the last decade reduced operating costs by 3.2 to 19.9 percent in the five service areas examined. The largest cost reductions were in East Los Angeles and South San Francisco. Both of these service areas are dependent on high-cost imported surface water. Reducing dependence on this expensive water provided a significant financial benefit to customers. The other three service areas rely more on local groundwater, which has a much lower avoided cost. Consequently, the cost savings in these three districts are significantly lower than in the two districts reliant on imported surface water.

We believe the estimates in Table ES-1 are conservative for two reasons. First, and most importantly, they do not account for the potential long-run cost impacts of the Sustainable Groundwater Management Act (SGMA). Three of the five service areas included in this study – Bakersfield, Chico, and Selma -- are located within high priority and/or critically over-drafted groundwater basins. SGMA is expected to impact the future use and cost of groundwater in these service areas. Historically, groundwater has been a primary source of supply in these districts. Second, we have not taken into account avoided wastewater costs because the data needed to estimate these impacts were not available. Nonetheless, over the long-run, conservation can lower the demand for both water and wastewater service, thereby helping to avoid or defer costly investments in additional water supply and wastewater system capacity.

Even so, the analysis strongly indicates that Cal Water's sustained drive to lower per capita water use over the last decade has financially benefitted its customers. Absent the reductions in per capita demand that have occurred since 2008-09, we conservatively estimate that bills in the five study districts over the 2010-19 period would have been 3.2 to 19.9 percent higher than was actually the case. Instead, Cal Water spent an amount of money on conservation that was more than offset by lower water production costs, deferred capital spending, and other reduced costs. Avoided operating expenses (OpEx) and deferred capital expenditures (CapEx), resulting from conservation investments, can yield a large economic benefit to today's customers. In short, Cal Water's investments in water efficiency have produced more sustainable per-capita demand, lower water system costs and, hence, lower water bills for its customers.

Investing in water conservation directly benefits customers by helping to slow the increase in water service costs over time. Economic investments in water efficiency are critical to help ensure that water utilities can continue to provide water service that is both affordable and sustainable.

Section 1: Introduction

California Water Service (Cal Water) provides water service to residents of 24 service districts across the state. Cal Water has invested substantially in water efficiency and conservation since the late 2000's. In addition to water conservation, water loss control programs, and universal metering programs, Cal Water has implemented tiered rate structures to promote water efficiency. These innovative strategies related to water efficiency, conservation, and rates over the years pose the questions:

- "What would the economic impact on bills been if none of these activities occurred?"
- "Are rate payers better or worse off?"

The relationship between conservation and water rates is not always well understood. Many water professionals and customers are perplexed by rate increases when system-wide water use has gone down, and blame water conservation and efficiency as the culprit for higher rates.

This report provides evidence that this causality needs to be reversed: Higher water rates in a tiered structure send an intentional price signal to customers about the cost consequences of consumptive choices. Water rates that communicate cost consequences to customers provide the information basis for informed choices about efficient water use. Implementation of conservation water rates, universal metering, efficient plumbing standards, and long-term conservation programs have lowered utility operating costs in the short and long term. This ultimately lowers the cost burden on water customers. This Report explores this dynamic by evaluating the costs that have been avoided by Cal Water's water efficiency efforts, and the impact this has had on customer bills.

Specifically, this report provides a technical estimation of the economic benefit of conservation efforts over a more than decade period by using avoided marginal costs of water service to value the savings. Historical roots of this analysis can be found in the benefit evaluation of public investments (Dupuit, 1844) and the institutionalist literature on avoided costs and efficient utility pricing (Boiteux, 1949).

We believe the estimates presented herein are conservative. The most recent available estimates of avoided water supply costs occurred prior to implementation of the Sustainable Groundwater Management Act (SGMA); there were no identified long run supply costs for three of the districts that lie in critically over-drafted groundwater basins. A very different estimate of long run supply costs might be obtained today to account for the SGMA compliance—that is, the cost of sustainability. Additionally, the estimates do not include avoided wastewater costs because the data needed to estimate these impacts were not available. However, over the long-run, conservation can lower the demand for both water and wastewater service, thereby helping to avoid or defer costly investments in additional water supply and wastewater system capacity.[1] Cal Water's investments in water efficiency have produced more sustainable per-capita demand, lower water system costs and, hence, lower water bills for its customers.

[11] See Fiske, G. and T.W. Chesnutt, (2010) The California Urban Water Conservation Council Wastewater Avoided Cost Model: Final Report, A report for CUWCC and the US EPA.

Section 2: Districts in the Analysis

Five Cal Water districts were selected for this analysis: Bakersfield (BK) and Selma (SEL), located in the central and southern San Joaquin Valley, respectively; Chico (CH) located in the northern Sacramento Valley; South San Francisco (SSF); and East Los Angeles (ELA). These districts vary in terms of avoided costs, level of conservation savings, and historical reductions in water use, as shown in Table 2.

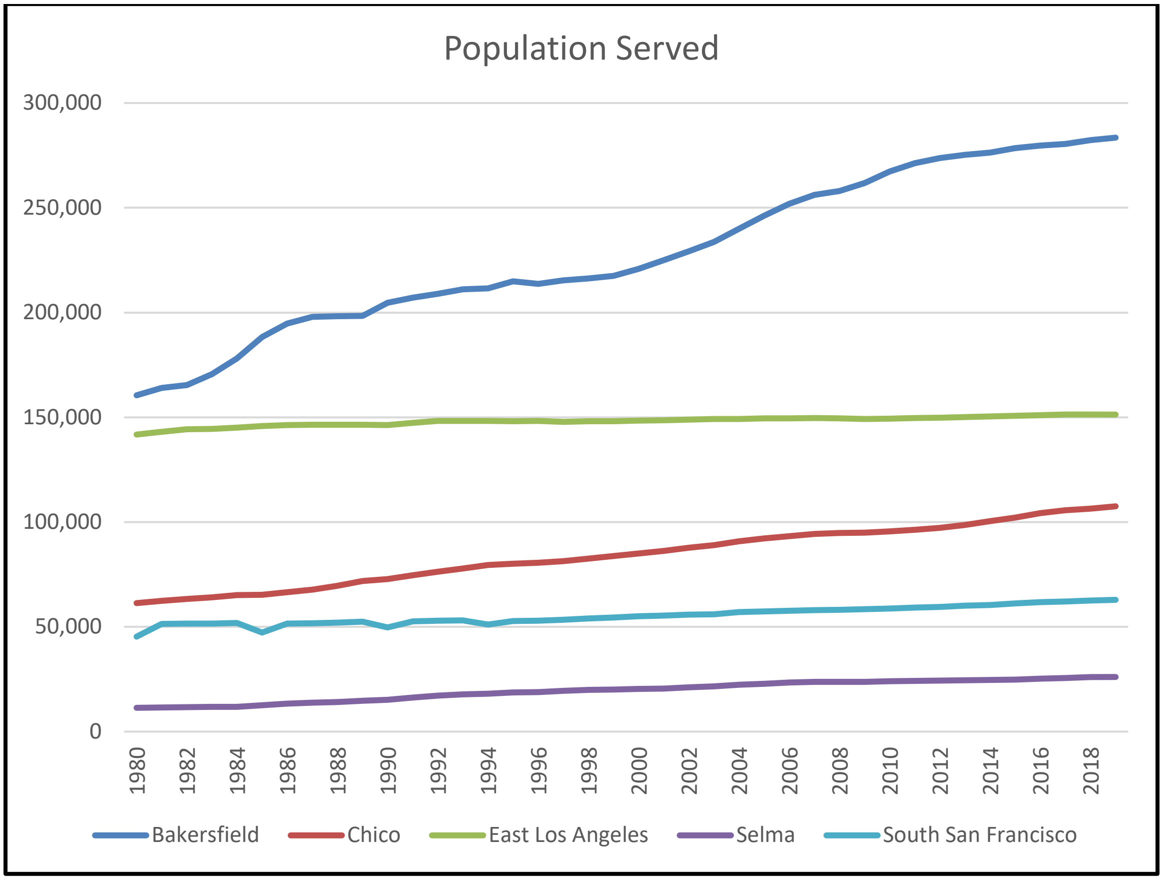
Table 2 District Selection Criteria

		1) Avoided Supply Cost	2) Savings vs. Sales	3) GPCD Reduction
Selma	**SEL**	Low	High	High
South San Francisco	**SSF**	High	High	High
Bakersfield	**BK**	Medium	Medium	High
Chico	**CH**	Medium	Medium	High
East Los Angeles	**ELA**	High	High	Medium

- Selma has traditionally had a low avoided cost of supply, primarily the cost of well water. It has demonstrated both high sales reductions and GPCD reductions.
- South San Francisco exhibits a high value across all three qualitative characteristics.
- Bakersfield possesses a warmer inland climate with high expected outdoor use. It has a growing population with a suburban customer base.
- Chico possesses a relatively warm climate with high expected outdoor use. It has a growing population with a suburban customer base.
- East Los Angeles is in a primarily urban setting with a high share of multi-family housing, high housing density (persons per dwelling unit) and relatively small irrigation use due to smaller yards.

Figure 1 summarizes population trends in the five districts. Note that Bakersfield and Chico exhibit significant growth over the period of analysis.

Figure 1 Trends in Population Served



Section 3: Historical Consumption

We expect to see demand growth where there is growth in population, but we also expect there to be differential conservation savings for a range of reasons:

- Rate increases. In general, the cost per unit volume of water faced by consumers was flat in real dollar terms (inflation-adjusted) from 1990 to about 2007. Since 2007 the real price of water has been rising, more in some areas than others.
- Drought restrictions. A five-year drought ended in the early 1990s. Water shortages requiring voluntary calls for customer water restriction occurred at various times thereafter. In response to severe drought, the state mandated urban water conservation in 2015 and 2016.
- Passive conservation. Since national water efficiency standards were set for low flow shower heads and 1.6 gallon per flush toilets in the National Energy Protection Act of 1992, there have been continuing federal and state improvements in plumbing fixture efficiency on an ongoing basis.
- Active conservation. Cal Water is a long-standing member of the California Urban Water Conservation Council (CUWCC) and its successor organization, the California Water Efficiency Partnership. It is also a member of the national Alliance for Water Efficiency. In conformance with the guiding principles and policies of these organizations, Cal Water has implemented a wide range of water conservation best management practices and programs to help its customers use water efficiently.

Figure 2 summarizes volumetric demand trends over the period of analysis. As expected, due to population growth, Bakersfield and Chico volumetric demand grows through 2007. After 2007, volumetric demand declines for all districts, including those with continued population growth.

Figure 2 Volumetric Customer Water Demand (AFY)

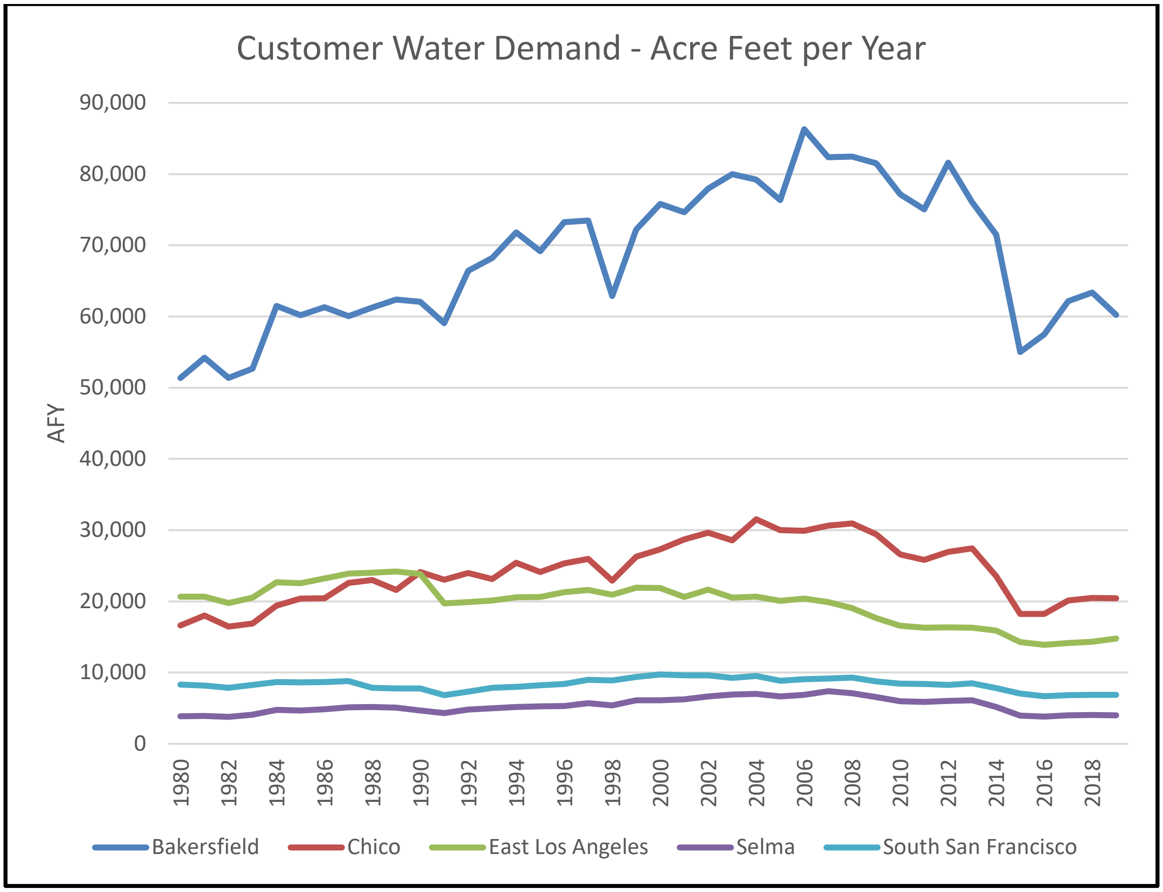
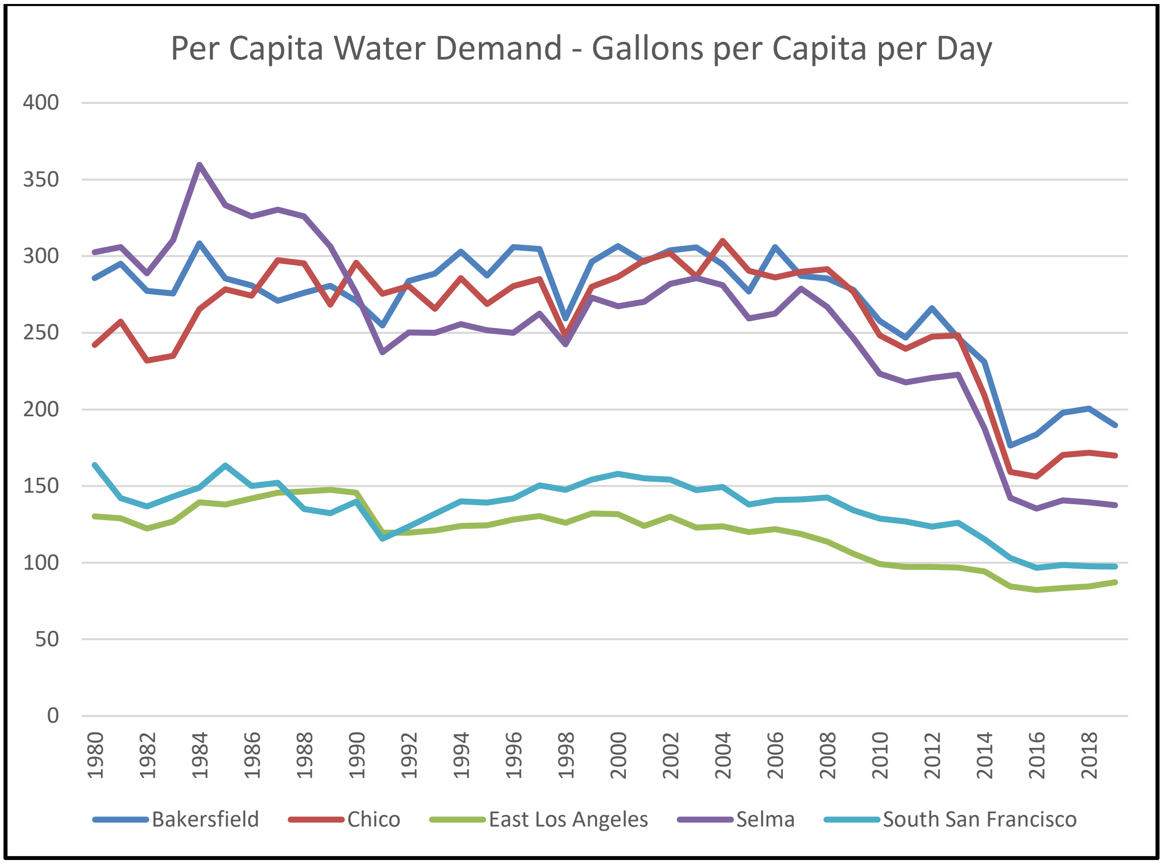


Figure 3 displays demand in per capita terms (GPCD) over the same period of analysis. We see that until 2008-09 gpcd is relatively flat. After 2008-09 GPCD demand visibly declines until 2015-16. All of the districts show at least a dip in demand during the drought of the early 1990s.

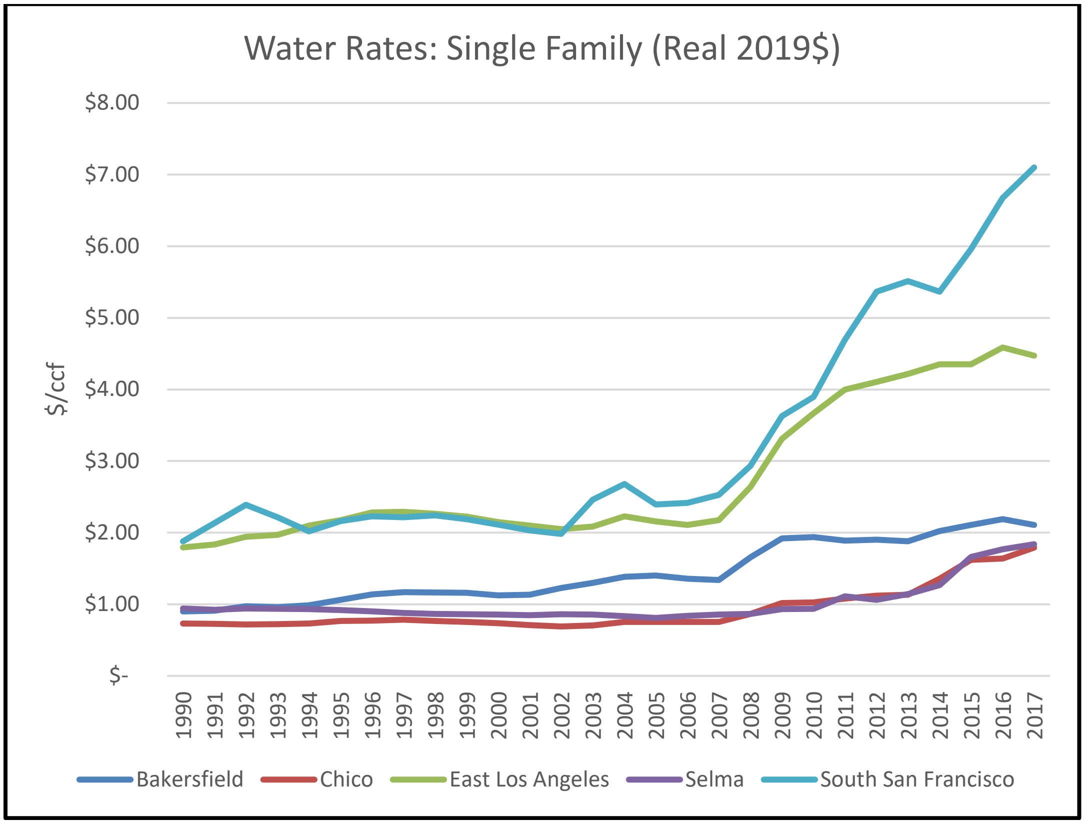
Figure 3 Per Capita Water Demand GPCD



Section 4: Water Rates

Figure 4 shows median single-family water rates from 1990 to 2017. Notice that the rates increase slowly until the 2007-time frame, and after that rates increase at a steeper rate. East Los Angeles and South San Francisco have much higher rates than the other districts, because of their dependence on imported water.

Figure 4 Real Water Rates (2019$)



Section 5: Avoided Costs

Cal Water commissioned studies in 2012 and 2015 to estimate the avoided water supply cost for each of its service areas (M.Cubed, 2012; M.Cubed, 2015). Those studies used the CUWCC/Water Research Foundation Avoided Cost Model to estimate the costs that a water utility would avoid as a result of each acre foot of water conserved. The CUWCC/Water Research Foundation model estimates both short run and long run avoided costs, and differentiates between water saved in the peak and off-peak seasons.

For this analysis, we have updated the estimates to 2019 dollars and we have used the CPI-U Water and Sewer index to extend the estimates back to 1990. These estimates are shown in Figures 5 and 6. As shown by the figures, avoided costs are significantly higher for East Los Angeles and South San Francisco, which primarily rely on imported surface water, than for Bakersfield, Chico, and Selma, which mainly or exclusively rely on local groundwater.

While avoided cost is used as the primary measure of benefit in this report, it is important to recognize its limitations in districts where water supply comes mainly or exclusively from an over drafted groundwater basin, as is the case for Bakersfield, Chico, and Selma. In this circumstance, the avoided cost estimate is not capturing the negative externality cost of continued overdraft of the groundwater resource and therefore is going to understate the value of demand management programs in these districts. As noted in the introduction, SGMA will eventually compel groundwater users to jointly address groundwater overdraft and this is expected to entail substantial future capital investment in new sources of surface or recycled water supply as well as possible new fees and limitations on groundwater pumping. However, these future costs are still uncertain and therefore are not reflected in the avoided cost estimates used for this report.

Figure 5 Avoided Costs: High Avoided Cost Districts (Real 2019$/AF)

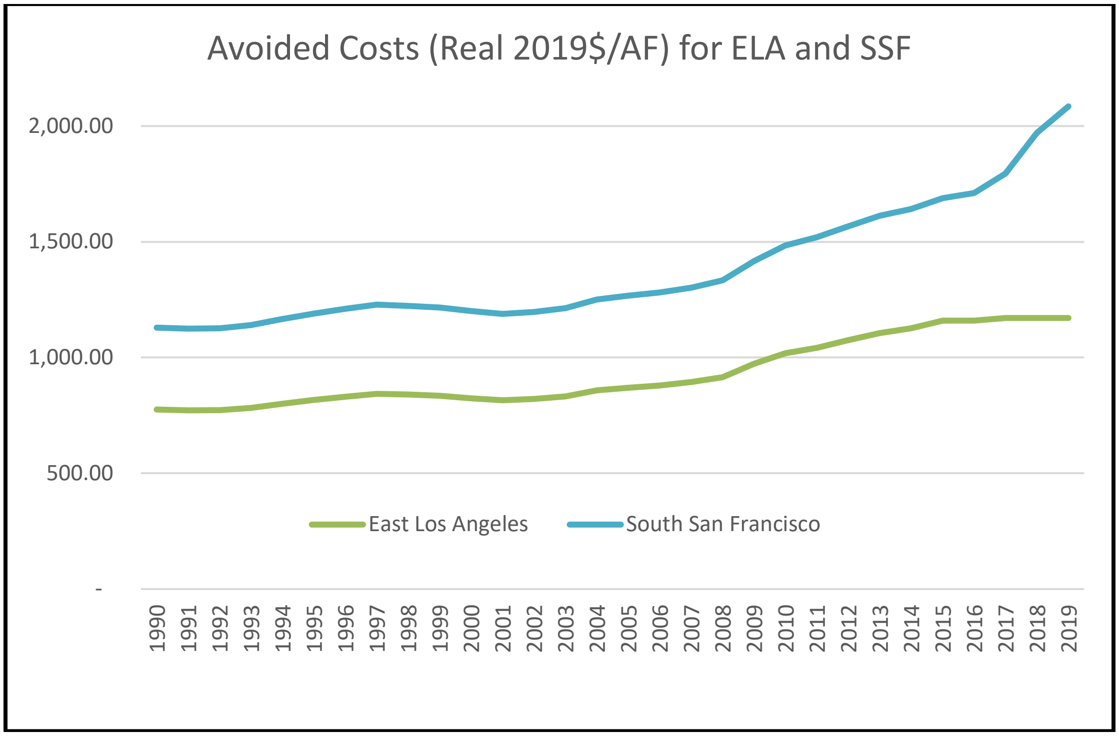
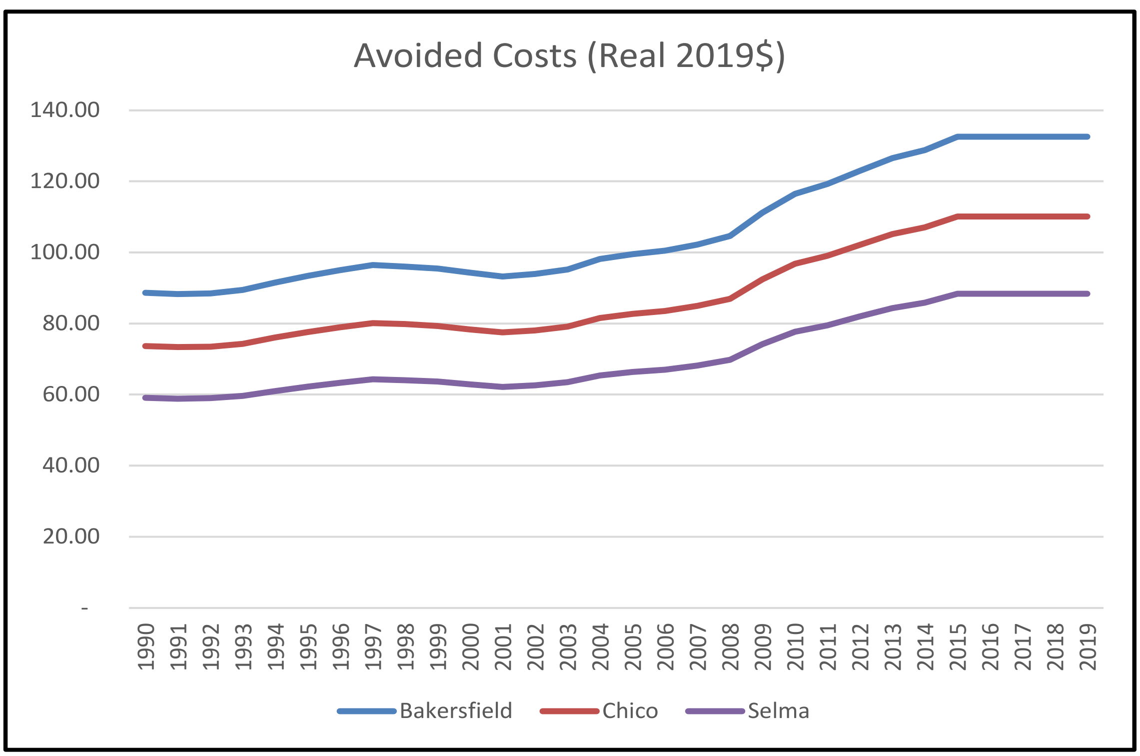


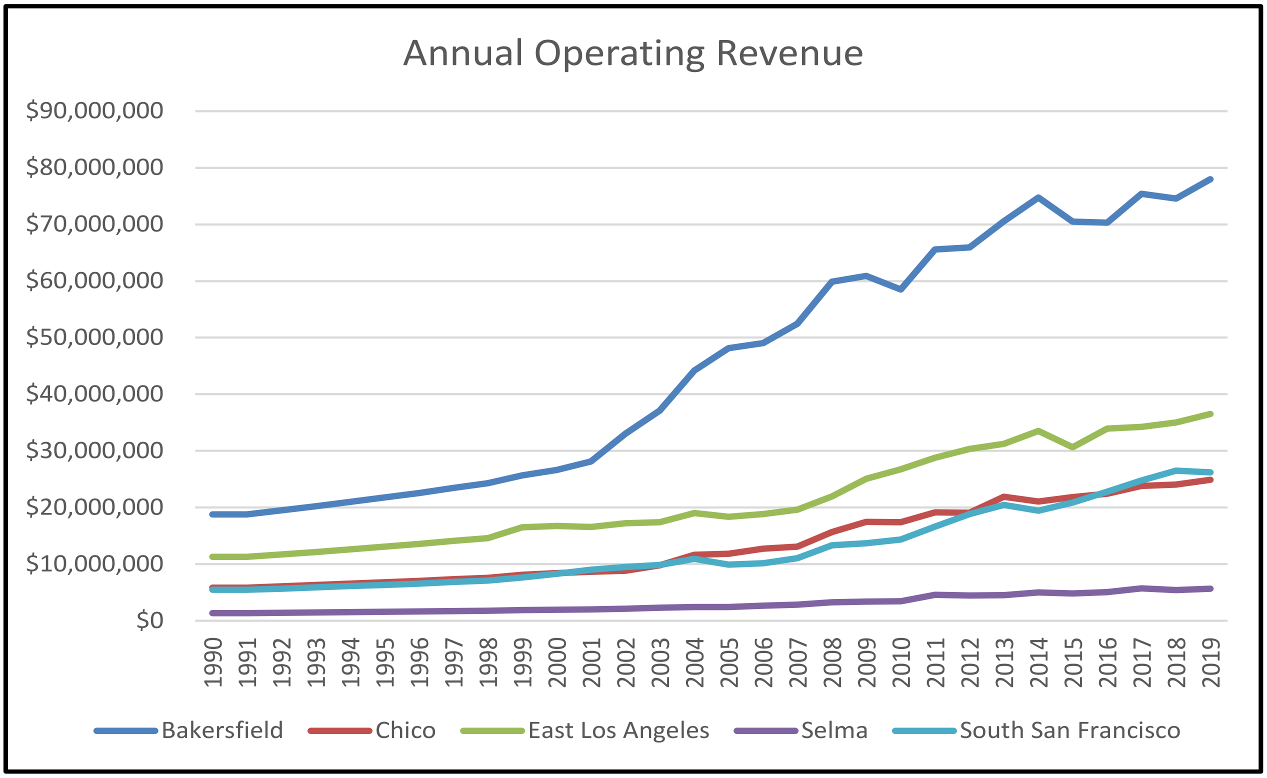
Figure 6 Avoided Costs for Three Districts



Section 6: Annual Operating Revenue and Demand

Figure 7 depicts the operating revenues at each district. Operating revenues are closely associated with the revenue requirements used to set customer bills. To understand the relative magnitude of the costs avoided by efficiency, these costs are compared to operating revenue. Cal Water provided operating revenue data for each of the five districts.

Figure 7 Annual Operating Revenue



The series of graphs in Figures 8 through 17 show demand and population used to calculate gpcd for each of the districts, and the actual demand and the counterfactual demand calculated with constant gpcd.

Figure 8 Bakersfield Demand versus Population

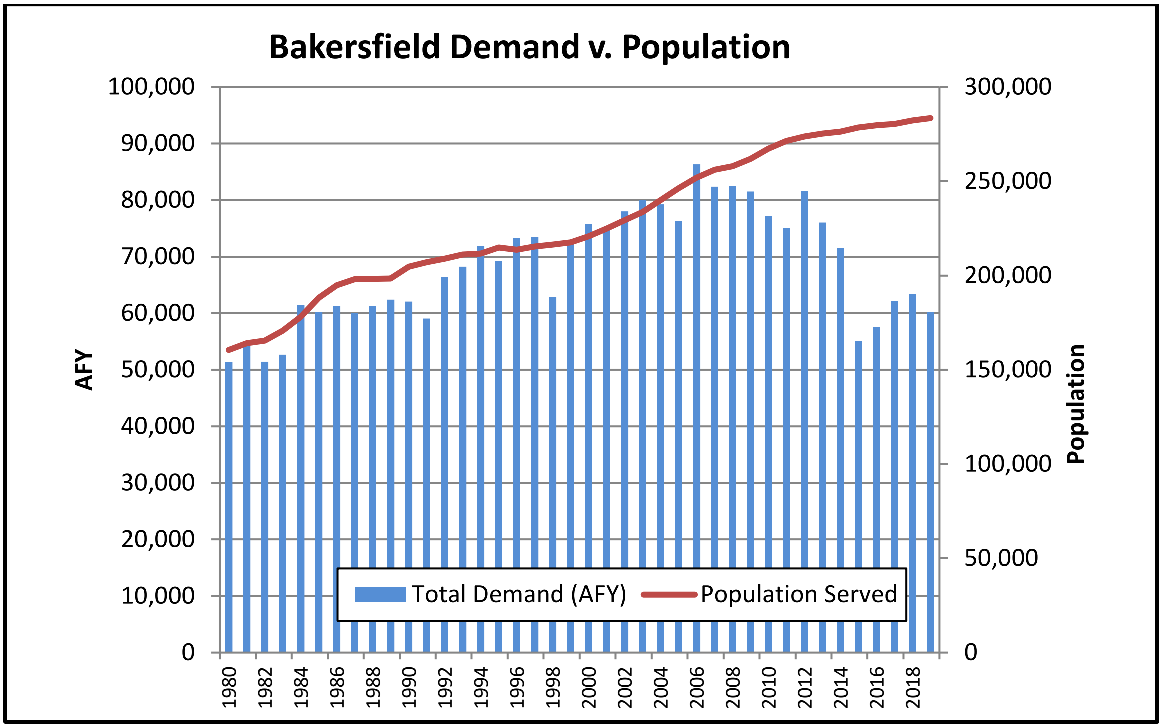


Figure 9 Bakersfield Historical Population versus Demand

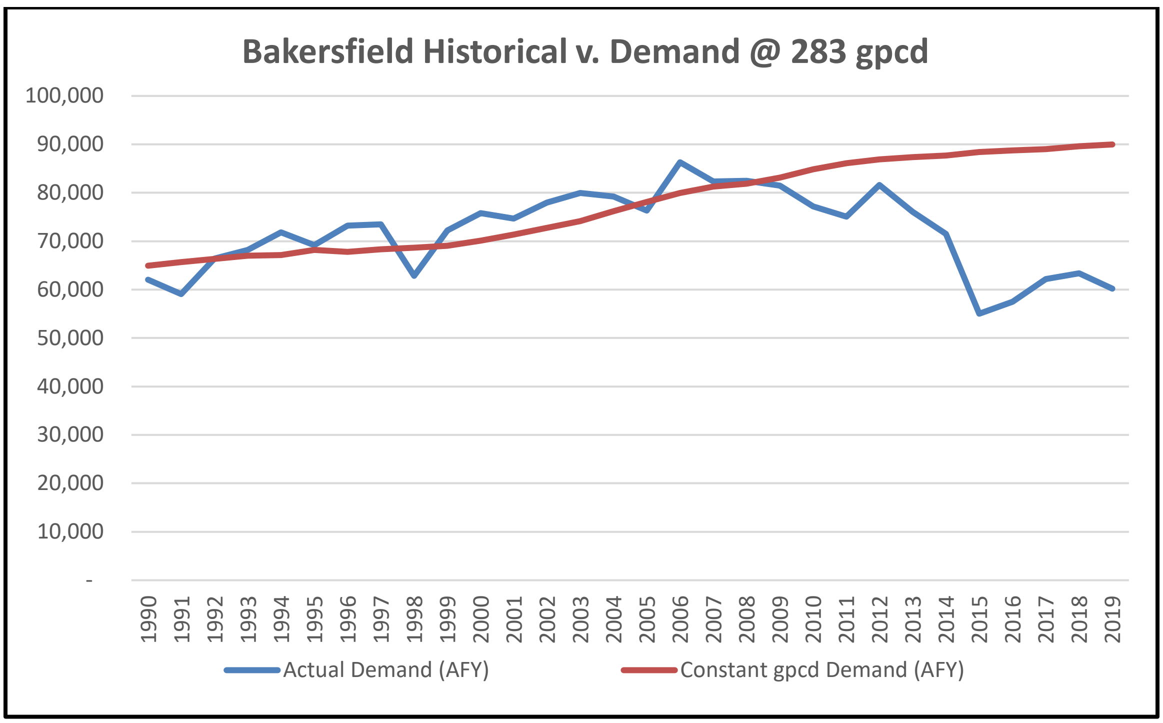


Figure 10 Chico Demand v Population

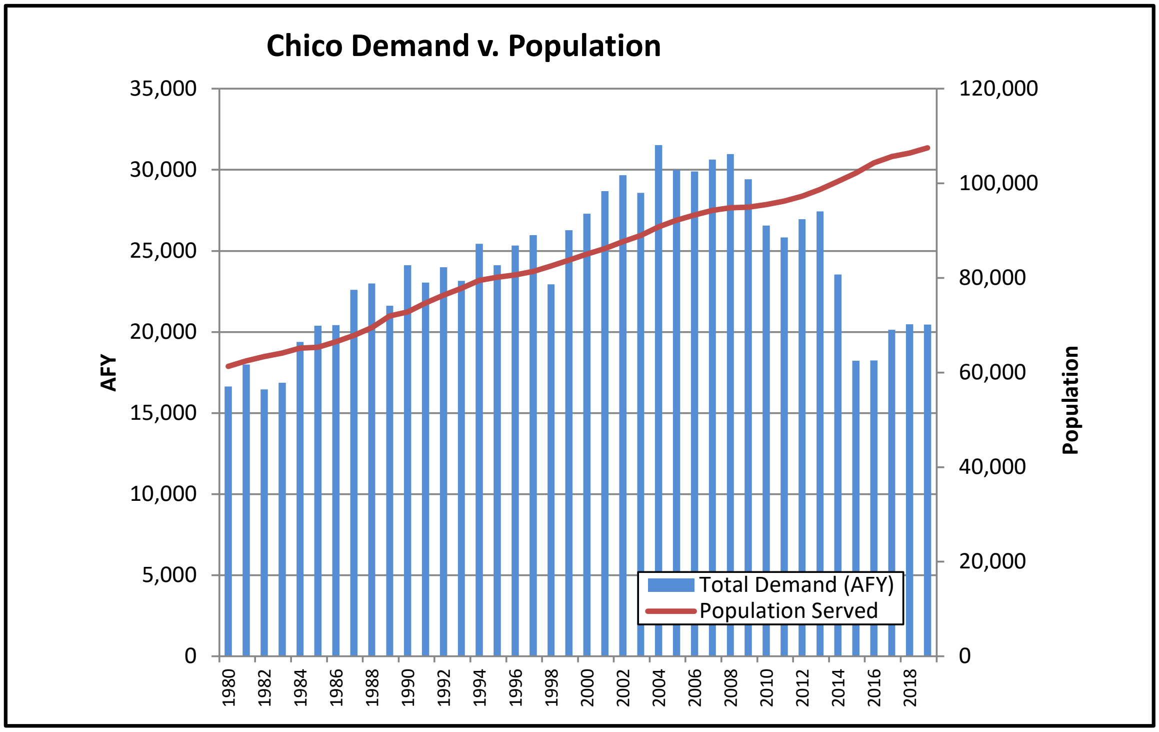


Figure 11 Chico Historical v Demand

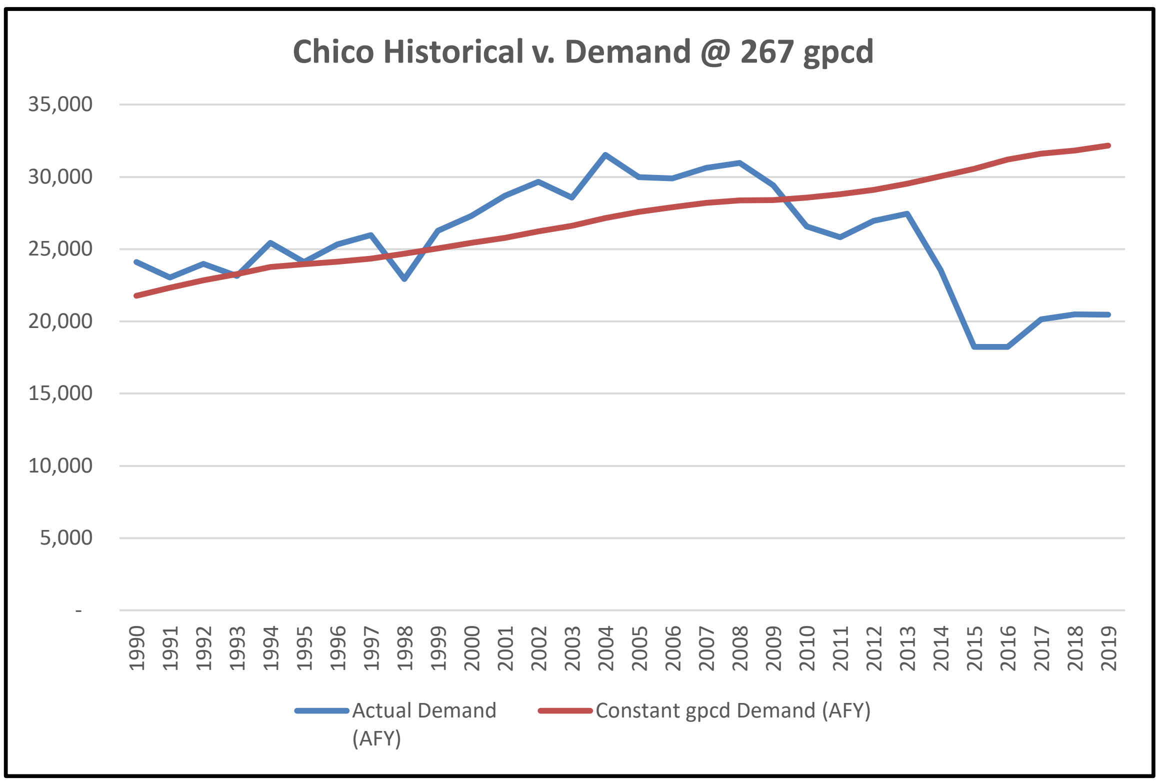


Figure 12 East Los Angeles Demand v Population

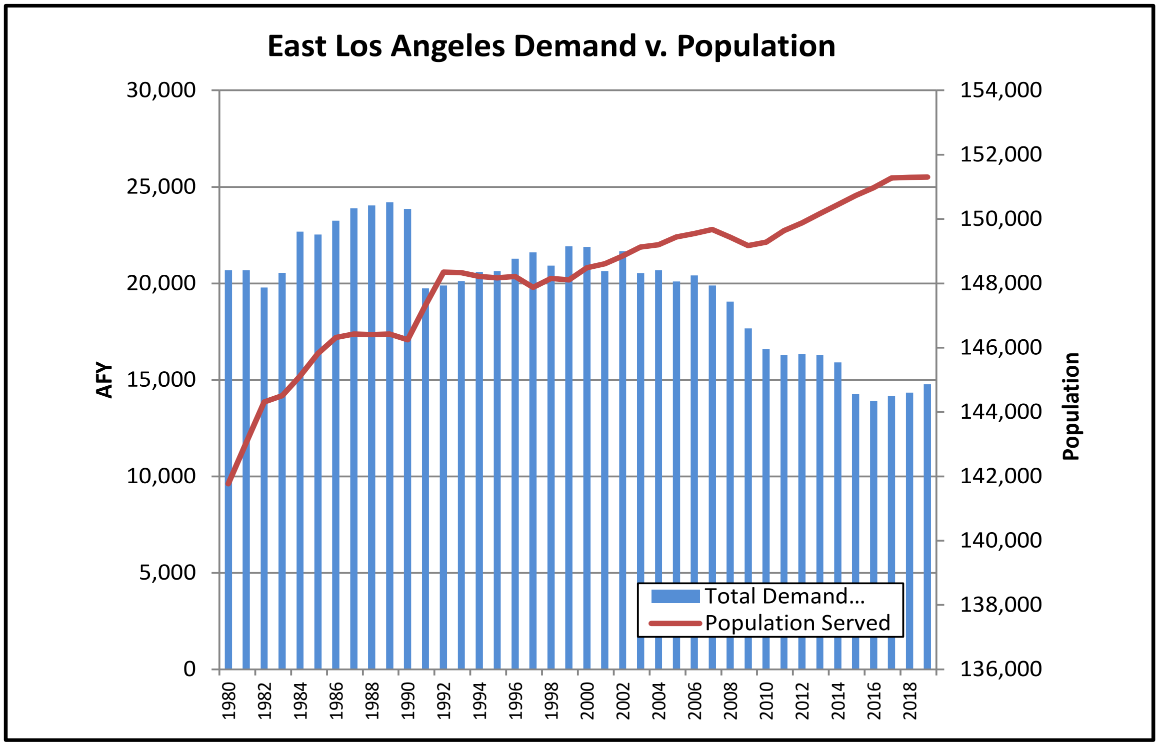


Figure 13 East Los Angeles Historical v Demand

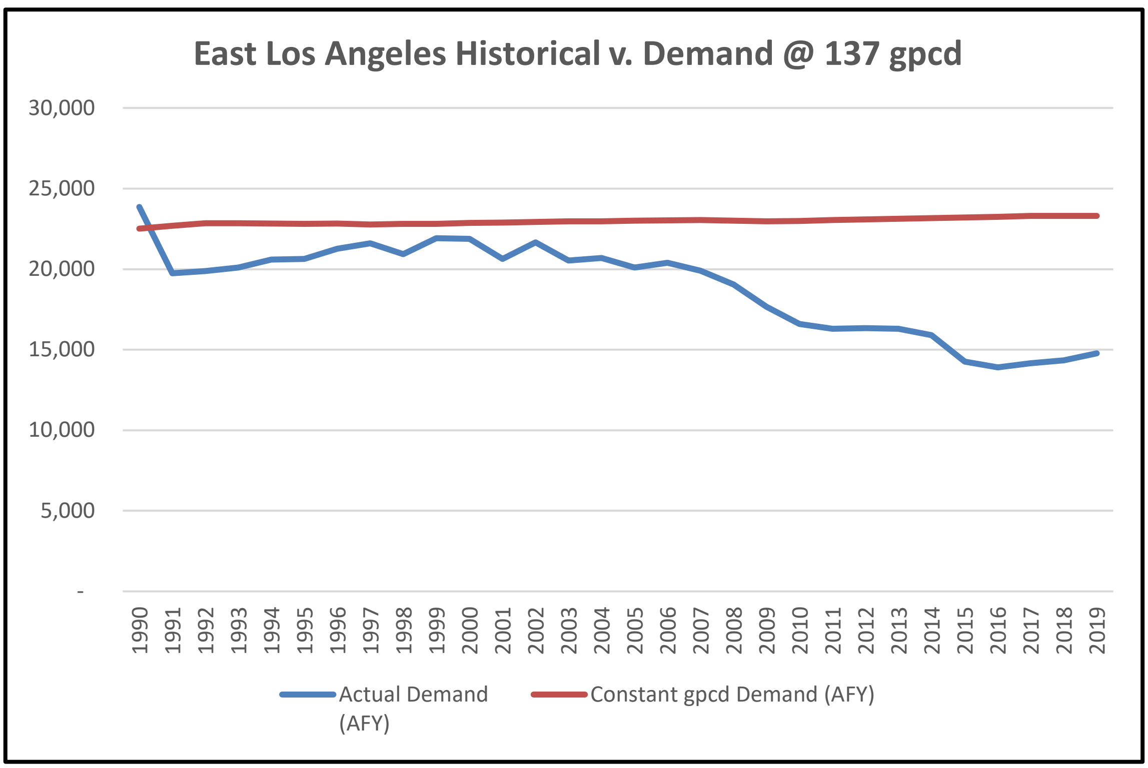


Figure 14 Selma Demand v Population

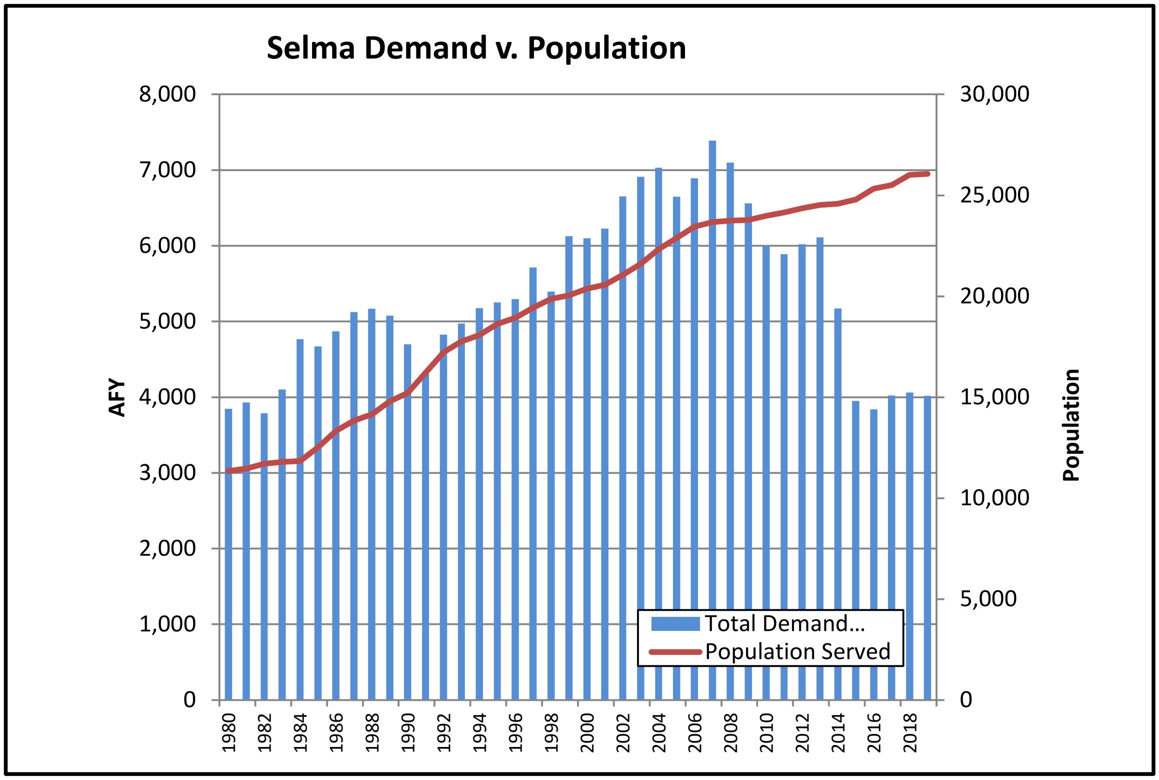


Figure 15 Selma Historical v Demand

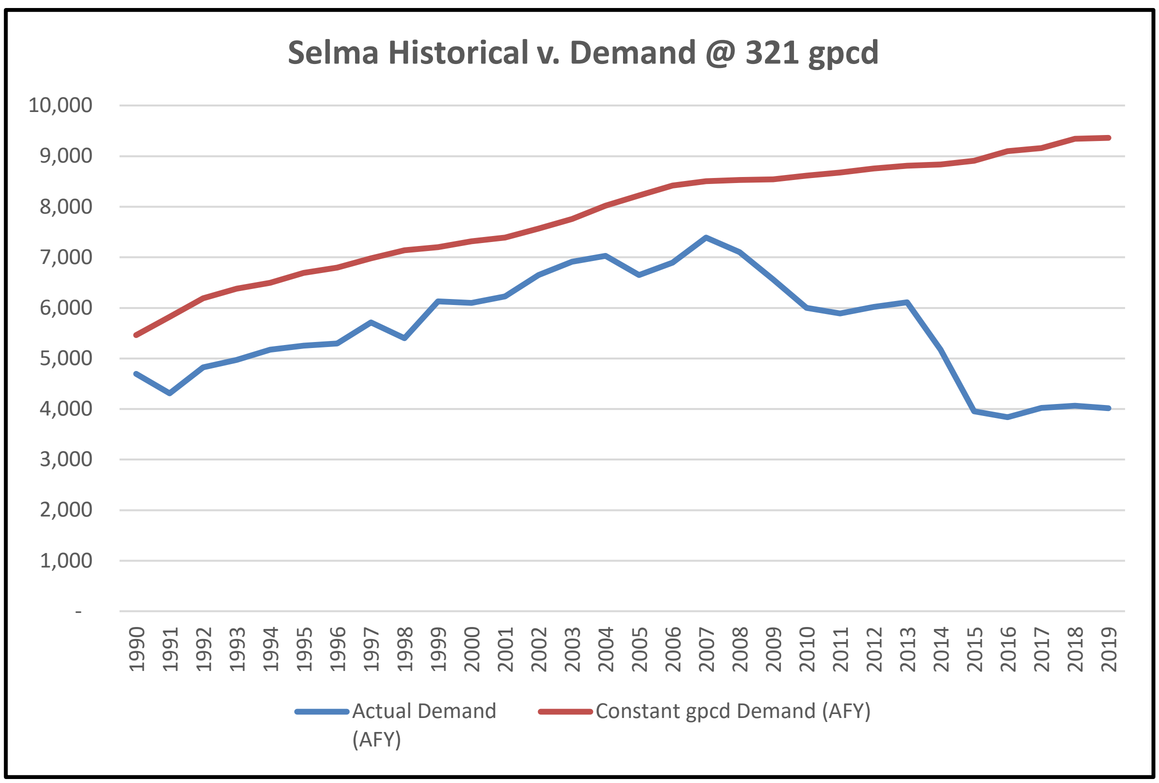


Figure 16 South San Francisco Demand v Population

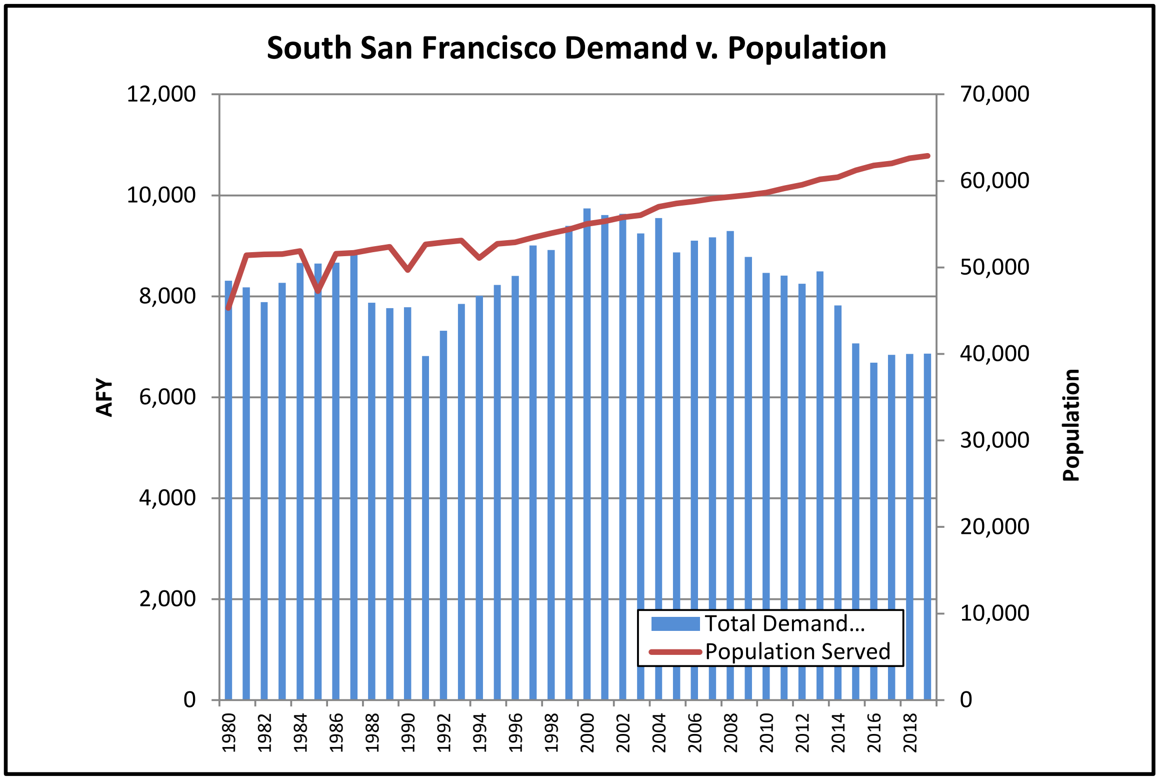
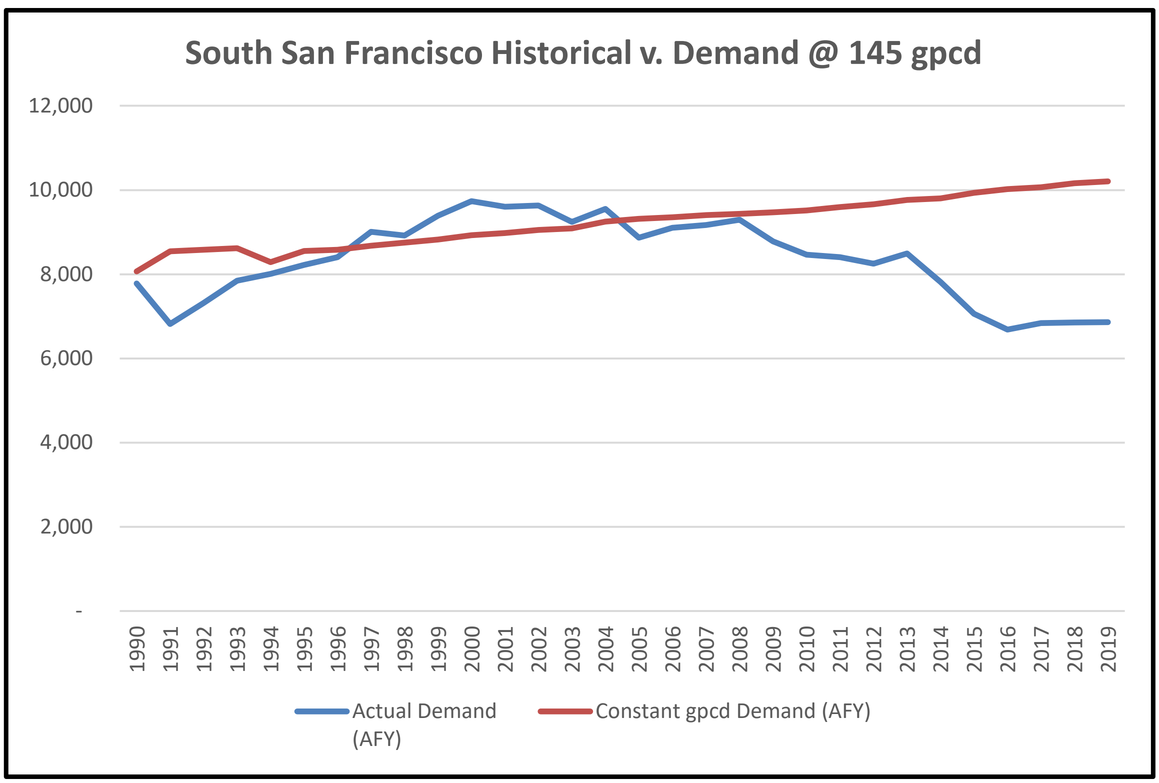


Figure 17 South San Francisco Historical v Demand



Method

1. Compute per-capita water demand in gallons per capita per day (gpcd).
2. Average gpcd for the baseline period -- historical years 1981 to 1989, prior to the advent of utility-sponsored plumbing code changes that required higher levels of water efficiency
3. Calculate counterfactual demand assuming the constant gpcd level from the baseline period.
4. Calculate difference between counterfactual demand and actual demand. This difference is conservation savings.
5. Multiply the avoided cost per acre-foot (2019$/AF) by the volume of conservation savings (AF) each year. Avoided costs in the year 2015 were estimated in previous work for each district (in 2013$ which were then converted to 2019$.) A complete historical time series of avoided costs were back-casted from 2014 to 1990 using the CPI-U for Water and Sewer. These were then expressed in 2019$ using the California CPI-U.
6. The time series of annual avoided costs were summed over the historical years and compared to the sum of operating revenues over the same period. The percentage change in customer water bills was estimated by comparing the estimated avoided cost savings to the actual total operating revenue over the period of analysis.

Section 7: Results

Table 3 shows the summary of results for each of the districts: All districts showed a reduction in customer water bills. The results show that the districts with relatively low avoided costs have smaller percent reductions in customer bills. East Los Angeles and South San Francisco, with their higher avoided costs due to purchased water, have achieved significantly higher percentage reductions in customer bills.

The calculations within Table 3 can be understood as follows. The first two rows show the unit marginal costs (avoided costs) for the first and last year of the analysis period, expressed in constant 2019 dollars. The third row shows the marginal cost (avoided costs) multiplied by the difference in demand between the counterfactual and actual demand; this annual avoided cost is then summed over all historical years. The fourth row shows the sum of operating revenue over the period of analysis. The fifth row shows the estimated cumulative operating costs *without* conservation. The sixth row shows the percent bill reduction, assuming the avoided cost savings reduce what would otherwise need to be collected in operating revenue.

Table 3 Estimate of Economic Benefit of Water Efficiency from 2010 to 2019: Reduced Customer Bills by District

Estimate of Economic Benefit of Water Efficiency from 2010 to 2019: Reduced Customer Bills					
Item	**Bakersfield**	**Chico**	**Selma**	**East Los Angeles**	**South San Francisco**
Unit MC Cost in 2010 (2019$/AF)	$116	$97	$78	$1,019	$1,484
Unit MC Cost in 2019 (2019$/AF)	$133	$118	$88	$1,171	$2,271
MC times Demand Difference, Sum 2010-2019 (2019$)	$25,927,533	$8,590,006	$3,487,073	$88,930,624	$41,342,419
Operating Revenue, Sum 2010-2019 (2019$)	$788,008,130	$240,943,805	$54,479,752	$358,988,597	$234,468,985
Estimated 2010-19 Cumulative Operating Costs w/o Conservation	$813,935,663	$249,533,811	$57,966,825	$447,919,221	$275,811,404
Percent Bill Reduction due to Conservation, 2010-2019	3.2%	3.4%	6.0%	19.9%	15.0%

Discussion

These estimates are believed to be conservative. The most recent estimates of avoided water costs occurred prior to implementation of the Sustainable Groundwater Management Act (SGMA); there were no identified long run supply costs for three of the districts that lie in critically over-drafted groundwater basins. A very different estimate of long run supply costs might be obtained today to account for the SGMA compliance costs.

It could also be asserted that the direct costs of conservation programs would be an avoided cost within the constant GPCD scenario.[2] In the last decade, conservation program budgets for these five districts have ranged from 1% to 1.7% of operating revenues.[3] Changing the customer bill reductions by one percent does not flip the result.[4]

Similarly, we have not included any avoided costs associated with reduced wastewater flow. Given that wastewater bills have been approximately matching water bills in the state of California, the estimate of the combined customer water and wastewater bills might be twice as high as the bill reduction for water alone. Cal Water's investments in water efficiency have yielded a payoff of reduced customer bills for its customer billpayers.

Cal Water's investments in water efficiency have produced more sustainable per-capita demand, lower water system costs and, hence, lower water bills for its customers. In California's urban areas, monthly water bills have been outpacing general price inflation for some time now (Hanak et al., 2014). Water service affordability is a growing concern in California and nationally (Hiltzik, 2017). Increases in water service cost are being driven by multiple factors, including the need to rehabilitate or replace aging infrastructure, new and more stringent water regulations, higher costs for construction, and growing competition for available water supply (Griffin, 2001). Investing in water conservation is a proven way to attenuate the rise in system costs over the long-run. In regions with high water supply and infrastructure costs, water conservation is often the least-cost way to meet future water demands (Gleick et al., 2003). Deferring or reducing the need for new water supply infrastructure through increased conservation can yield large dividends for ratepayers, as this study has shown.

These results are not anomalous, but rather extend a wide body of research into the long-run benefits of conservation for utility ratepayers. For example, the Los Angeles Department of Water and Power has calculated that its residents and businesses paid water rates that were 27% lower because of investments in water conservation over the previous three decades (Chesnutt, Pekelney, and Spacht, 2019). A similar study for Tucson, Arizona, concluded that water conservation helped the city avoid hundreds of millions of dollars in water and wastewater operating and capital costs (Rupprecht, 2020). In yet another study, the City of Westminster, Colorado, calculated that its residents and businesses paid water and wastewater rates that were 47% lower and development fees that were 44% lower because of investments in water conservation over the previous three decades (Feinglas et al., 2017). Investing in water conservation directly benefits ratepayers by helping to slow the increase in water service costs over time. Economic investments in water efficiency are critical to help ensure that water utilities can continue to provide water service that is both affordable and sustainable.

[2]Equally validly, conservation program expenditures could be argued to constitute nonavoidable compliance costs with the Statewide MOU on water conservation.
[3] Source: GRC conservation budgets and *Conservation Budget and Measurement & Evaluation Reports*.
[4] Universal customer metering is a non-avoidable cost due to statewide requirements. Water rate reform appears to have been accomplished with existing management resources.

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