Proposition 50 Chapter 6b, Consolidated Management of Nitrate Treatment: Affordability Assessment

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and

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Table of Contents

List of Figures

List of Tables

Introduction

The University of California, Davis (UC Davis) and Corona Environmental Consulting, LLC (Corona) have performed an affordability assessment as part of the Proposition 50 Chapter 6b project titled, "Consolidated Management of Nitrate Treatment: Implementation, Demonstration, and Affordability Assessment."

Nitrate contamination of potable water sources is a critical water quality concern for many small water systems. The federal maximum contaminant level (MCL) for nitrate, set by the United States Environmental Protection Agency (U.S. EPA), is 10 mg/L as nitrogen (N); the California MCL, set by the State Water Resources Control Board (SWRCB) Division of Drinking Water (DDW) is consistent with the federal MCL. Chronic non-compliance of some CA systems and the lack of affordable solutions to meet the nitrate MCL emphasize the need for an alternative approach, particularly for small water systems and economically disadvantaged communities. Small water systems face numerous barriers to implementing treatment solutions for nitrate: lack of in-house knowledge of and experience with the treatment process; lack of experience with management of capital treatment plant construction and operation; lack of knowledge of and experience with the plant permitting process; and additional overhead costs associated with sourcing the supply of consumables in the treatment process and responsible disposal of waste residuals.

The proposed approach is consolidated management of nitrate treatment. With the aim of minimizing small water system operations and maintenance (O&M) costs associated with nitrate treatment, consolidated management will entail sharing of chemical (salt) delivery, brine residuals management, and personnel (e.g., treatment system operator). This Proposition 50 project aims to provide proof of concept in the implementation of consolidated management of treatment for nitrate removal for a cluster of small water systems in the San Joaquin Valley (SJV). The objectives of the overall project are to:

- Identify key considerations for the implementation of a consolidated management approach;
- Demonstrate application of consolidated management;
- Perform household-level and utility-level affordability assessments; and
- Evaluate statewide application of consolidated management of small water systems for sustainable potable water treatment.

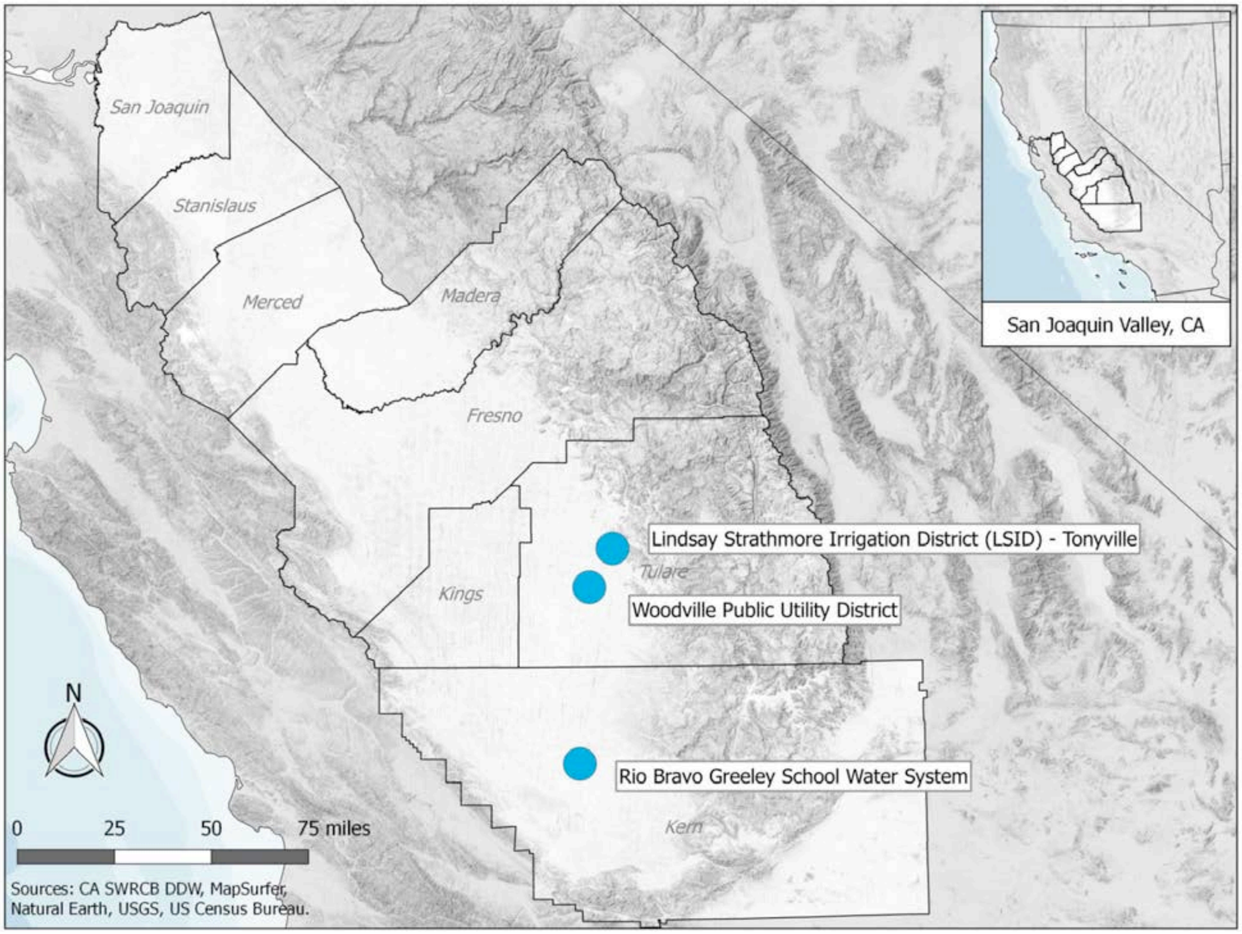
This report examines affordability of treatment with and without consolidated management, based on preliminary cost estimates provided by treatment equipment vendors. The project team will revise the affordability assessment to include actual costs upon installation and operation of treatment at the participating utilities. The objectives of the affordability assessment are to:

- Estimate and compare treatment costs with and without consolidated management;
- Develop and apply a range of informative household and utility affordability metrics;
- Evaluate a range of potential funding mechanisms to address affordability challenges for economically disadvantaged communities; and
- Formulate specific recommendations addressing affordability on a statewide basis.

Rio Bravo Greeley School Water System (RBG School), Lindsay Strathmore Irrigation District (LSID) – Tonyville (LSID-Tonyville), and Woodville Public Utility District (Woodville) are included in this assessment;

water system locations are shown in Figure 1. Please refer to the report titled *Proposition 50 Chapter 6b, Consolidated Management of Nitrate Treatment: Preliminary Assessment of Utilities and Treatment Cost Analysis* for additional background information (Corona Environmental Consulting & University of California, Davis 2018). The information gained from the proposed project will assist the participating water systems as well as small and/or disadvantaged water systems facing similar challenges statewide. Additionally, consolidated management has the potential to minimize costs for small and/or disadvantaged water systems facing not only nitrate contamination, but also other drinking water contaminants.

Figure 1. Participating water system locations in California's San Joaquin Valley.



The affordability of public water supply is a growing concern across the water sector because many factors – including water quality-related treatment and compliance needs – are causing drinking water, wastewater, and stormwater rates to escalate much faster than the rate of general inflation (Federal Reserve Economic Data 2017)(see also Figure 3, below). The affordability challenge is especially critical in many small communities, due to the economies of scale generally associated with water treatment technologies, including those available for meeting nitrate standards to protect human health. The affordability challenge facing customers of small public water supply (PWS) systems is further compounded in economically disadvantaged communities, where household incomes are often well below state and national averages.

The State of California recognizes the extent of the affordability challenge associated with providing safe drinking water in small disadvantaged communities. Efforts to address this challenge include considerable funding support from the California Department of Water Resources (DWR), with technical support from DDW, in the form of grants to cover the up-front capital expense of installing water treatment technologies to address public health concerns, such as elevated nitrate levels in drinking water. Yet, even with the funding of large-scale capital investments in treatment technologies, small water system customers in economically disadvantaged communities may still face considerable financial hardship in covering the necessary O&M expenses associated with treating their drinking water to meet key public health standards.

As noted by Pacific Institute and Community Water Center (2013):
"In California, water affordability has taken center stage since the passage of two landmark Assembly Bills in 2012: AB 685 and AB 2334. As the first state law in the United States to explicitly recognize the Human Right to Water, AB 685 notes that 'every human being has the right to safe, affordable, and accessible water adequate for human consumption, cooking, and sanitary purposes' as set forth in Section 106.3 of the California Water Code (CWC). Focused more explicitly on water affordability, AB 2334 requires the Department of Water Resources to include an analysis of water affordability and mechanisms to address lack of drinking water (and wastewater services) affordability in California's Water Plan."

Previous relevant work in the region has included examination of nitrate contamination, small water system challenges, funding mechanisms, and affordability (Pacific Institute 2011, Harter et al. 2012, Pacific Institute & Community Water Center 2013, Tulare County 2014, London et al. 2018, Feinstein 2018, Balazs et al. 2019). This affordability assessment is informed by, and builds upon, the findings of the previous efforts in the region, with development of informative affordability metrics, assessment of treatment costs with and without consolidated management, evaluation of funding mechanisms, and recommendations for specific action.

This report has several goals:

- To provide readers enough background on drinking water affordability to understand the research.
- To evaluate household-level and utility-level affordability for three specific systems in California's Central Valley.
- To formulate specific recommendations on how to develop and maintain safe and affordable water, even in small economically disadvantaged systems.

Part 1: Costs and Affordability of Water Services – Background

The federal Safe Drinking Water Act (SDWA), signed into law in 1974, created uniform drinking water standards that are enforceable throughout the United States. The SDWA also provided much needed government funds for water infrastructure through loans and grants. Passage of the Act has resulted in overall improvements to human wellness due to the significant reduction of water related illnesses. Consequently, more than 90% of water customers in the United States enjoy access to drinking water that meets all standards all of the time (Crow 2015).

Amendments to the SDWA in 1986 helped to further strengthen the Act's enforcement, required that the U.S. Environmental Protection Agency (EPA) issue drinking water standards for a significantly increased number of contaminants, and established two new groundwater protection programs. In 1996 Congress again amended the SDWA to emphasize sound science and cost-benefit analysis (CBA) in standard setting. It also set provisions for small water system flexibility and technical assistance, source water assessment and protection, public right-to-know, and water system infrastructure assistance through a multibillion-dollar state revolving fund.

There has been a consistent recognition throughout the history of the SDWA that there is need for adequate funding to support treatment processes and water system infrastructure. Further, as recognized by the 1996 amendments, the financial burden associated with complying with the SDWA is greater for some small systems and economically disadvantaged communities as roughly 96% of all public spending for water and wastewater utilities are provided primarily by local and state governments (Eskaf 2015). The majority of the funding from local governments is derived from customer paid water rates, surcharges and municipal bonds.

Components of Water Cost

Water system budgets are typically broken down into two categories: (1) operating and maintenance expenditures (O&M), and (2) capital expenditures. O&M includes expenses such as chemicals, fuel, replacement parts, energy, personnel, and contract services. Capital expenses include the purchase of new equipment, design and construction of new facilities, and rehabilitation to existing infrastructure. The total funding requirements for both categories have risen steadily since the SDWA was first signed into law (Eskaf 2015). In the last 10 years utilities' O&M costs have increased by 15% and are expected to account for 58% of total utility costs over the next decade (Civil + Structural Engineer Magazine 2018). Significant increases in capital expenditures are also expected over the next 25 years to renew or replace aging infrastructure and to update facilities with required additional treatment and needed modifications to accommodate the impacts of climate change (Jones & Moulton 2016, Frostenson 2017).

In response to rising costs, many water utilities have sought to enhance revenue through increased customer water rates and water rate restructuring. While the water rate increases have varied across the country, "increases have averaged 5.5% a year, more than three times the rate of inflation, according to the Labor Department" (Harrison 2018). A survey of water prices for households in 30 major U.S. cities indicated that water bills for a family of four increased roughly 41% from 2010 to 2015, which far exceeded pricing increases of any other household staple (LaFond 2015). Despite increasing rates, many utilities have rates that are still too low to generate the revenues needed to upgrade, operate, and maintain community water and wastewater systems (Mack & Wrase 2017).

Data from 30 major U.S. cities indicates that the average monthly water bill in 2018 for a family of four using 100 gallons per person per day is $70.39. Since water rates are based on a number of factors such as cost of treatment, maintenance, operations, labor, energy and the cost to obtain source water, water bills can vary greatly from one utility service area to the next. For instance, a family of four using 100 gallons per person per day in Fresno, California can expect to pay roughly $36 per month, whereas a family in San Francisco utilizing the same amount of water could expect a monthly bill around $140 per month (Walton 2018).

Affordability for Small Communities

The number of residential, commercial, and industrial service connections that are available to support the total cost of a water system can have significant impacts on the relative monthly bill for each customer. While large and small water utilities are subject to the same regulatory requirements and need to ensure consistent and adequate supplies, larger utilities are able to spread the cost of treatment and operations across a larger customer base than small utilities. In particular, customers of public water systems serving populations less than 1,000 are often more financially impacted by stringent water quality regulations as most applicable water treatment processes do not exhibit economies of scale for the small system size range (Raucher et al. 2011). Table 1 provides an example of the mean annual cost per-household of the arsenic MCL (10 µg/L) depending on the system size category.

Table 1. EPA estimate of household cost of arsenic treatment by system size in 2007 dollars (Raucher et al. 2011).

Water system population	EPA estimated annual household cost
25 - 100	$407
101 - 500	$202
501 - 1,000	$88
1,001 - 3,300	$72
3,301 - 10,000	$47
10,001 - 50,000	$40
50,001 - 100,000	$31
100,001 - 1,000,000	$25
> 1,000,000	$1
Average across all systems	$39

The 1996 amendments to the SDWA created provisions that allow EPA to consider technology variances for small systems that may not be able to afford the best available treatment technologies needed to meet Maximum Contaminant Level (MCL) regulations. In these cases, states could allow a small system to utilize a treatment technology that achieves the maximum removal of the contaminant that is both "affordable" and "protective of human health" but does not remove the contaminant to the degree required by the drinking water regulation. States, however, are only able to grant such variances in cases where the EPA has determined that the best available technology is not affordable and where the agency has also identified variance treatment technologies that achieve the maximum reduction in that contaminant level that is both affordable and protective of human health. The EPA established criteria of what is "affordable" in the context of the small system technology variance provision, but to date has not made a technology variance available to small systems (Raucher et al. 2011).

In 2011, California approved emergency regulations permitting Point-of-Use (POU) and Point-of-Entry (POE) devices for small community water systems (CWSs) unable to implement suitable centralized treatment to consistently meet MCLs due to cost. In cases where a water system would like POU or POE devices to be considered as an alternative to centralized treatment, the CWS must apply and be approved by the State Water Resources Board. Approval is contingent on a number of factors including the CWS's ability to prove it has fewer than 200 connections and that the cost of centralized treatment is not economically feasible based on affordability criteria set by the state. Once approved, the CWS must meet all compliance requirements for approved POU devices.

U.S. EPA Affordability Guidance and Metrics

The U.S. EPA initially developed affordability criteria to identify when federal *wastewater*-related mandates might result in "undue economic hardship" within a community (US EPA 1997). The objective of these criteria was to indicate when EPA might accommodate some flexibility (i.e., in the form of allowing a longer timeframe to achieve compliance) for utilities striving to meet applicable regulatory compliance obligations. EPA criteria include metrics for assessing both household affordability and utility capability for financing the required investments on reasonable terms.

To assess household affordability, EPA developed the Residential Indicator (RI). The RI weighs the average per household cost of wastewater service relative to median household income (MHI) within a utility service area. Ultimately, an RI of 2% or greater for wastewater is deemed to signal a "high financial impact" (US EPA 1997) on residential users, meaning that the community is likely to experience economic hardship in complying with federal water quality standards. Since the RI was introduced, the 2% threshold has served (until relatively recently) as the primary metric for assessing household affordability of wastewater services. However, there is no clear rationale on why EPA selected 2% as the point at which it deems wastewater costs to be unaffordable.

While EPA's consideration of affordability for wastewater compliance is aimed at assessing an individual community's ability to comply with regulatory mandates and schedules, EPA's consideration of affordability in the context of potable water supply is limited to assessing the *national-level affordability of regulatory options for small communities*, under the small system variance technology provision noted above. Specifically, EPA has stated that it would consider a National Primary Drinking Water Regulation to be unaffordable to small communities (those with populations under 10,000) if the standard would result in a household drinking water bill (averaged across all small systems) in excess of 2.5% of the national MHI in such communities (US EPA 2002). In this context, MHI is evaluated based on all small community water systems collectively (i.e., MHI is not considered for any individual utility, but for all small utilities lumped together). To date, EPA has never determined that a drinking water regulation is unaffordable for small systems. If EPA *were* to make such a finding, it would be required to identify technologies for small systems that might not result in meeting a particular drinking water standard but *are* found to protect public health. Then, on a case-by-case basis, states may approve the use of such affordable small system technologies (called a variance) or approve an extended deadline for compliance (called an exemption).

EPA's stated view on potable water —that it is affordable if it costs less than 2.5% of small community MHI—has influenced the perceived affordability of combined water and wastewater bills. Specifically, it is commonly inferred that EPA would consider a combined annual water and wastewater bill of less than 4.5% of MHI to be affordable (2.5% for water, plus 2% for wastewater services and CSO controls).

However, as described in Figure 2, MHI (and EPA's RI) can be a highly misleading indicator of household affordability for several reasons (AWWA, USCM, WEF 2013, AWWA 2014, Teodoro 2018a).

Figure 2. Limitations of EPA's RI and MHI as an indicator of water and wastewater affordability.

- MHI is a poor indicator of economic distress and bears little relationship to poverty or other measures of economic need within a community. For example, consider an analysis of MHI and poverty data for the 100 largest cities in the United States. It shows that for 21 cities identified as having an MHI within $3,000 of the 2010 national MHI ($50,046), there is no discernible relationship between MHI and the incidence of poverty. Indeed, within these 21 cities, the poverty rate ranges from a low of 14.1% to a high of 23.3%.
- *MHI does not capture impacts across diverse populations*. In many cities, income levels are not clustered around the median, but are spread over a wide income range or concentrated at either end of the income spectrum, making MHI a less meaningful metric. In addition, income distribution and other economic measures can vary widely across different districts and neighborhoods within a city. Thus, the economic hardship associated with increasing water and wastewater bills can be concentrated in a few lower-income neighborhoods. This will compound the economic hardship within the community and may raise issues of environmental justice. These impacts are not captured with the use of service area MHI as a primary indicator.
- MHI provides a "snapshot" that does not account for the historical and future trends of a community's economic, demographic, and/or social conditions. This is particularly relevant in areas that may be experiencing economic declines or population losses, which will result in the costs of water and wastewater programs being spread across fewer residents. Without consideration of these and other economic and demographic trends, the affordability determination will overestimate the ability of residents to tolerate rate increases over time.
- *MHI does not capture impacts to landlords and public housing agencies.* In cities with a high percentage of renters and/or public housing residents, use of MHI and RI does not capture impacts to landlords and public housing agencies, which must often absorb the cost of increased water and wastewater bills. In many cases, higher water bills mean that public housing authorities will be required to reduce the number of needy renters they serve, unless there can be offsetting increases in public housing budgets.
- The RI focuses on average per household cost of water-related services rather than basic water use. The numerator in the RI calculation reflects the average per household cost that a utility incurs to provide residential water sector services. It does not reflect the actual amount that low-income households pay, which is often much lower than the average household bill within a service area. As noted by Teodoro (2018a, p.14), "public policy discussions of water and sewer affordability seldom are concerned with the cost of maintaining large lawns, swimming pools, or other discretionary outdoor use. Rather, affordability is typically thought of as the ability of customers to pay for water and sewer services that are adequate to meet their basic needs for drinking, cooking, health, and sanitation."
- *The RI does not fully capture household economic burdens.* Economic burdens are commonly measured by comparing the costs of necessities to available household income. The RI is such a measure in that it is used to evaluate the economic burden from water bills by comparing those bills to MHI. However, the RI does not account for the costs of other non-discretionary items that make up a household budget (e.g., housing, health care, energy), and therefore does not capture the full economic burdens that lower income households face. This is especially problematic in areas that may experience high housing costs.

Text written by Corona staff for AWWA Report (AWWA, USCM, WEF 2013).

Alternative Affordability Metrics

Given the limitations of MHI and EPA's RI as appropriate affordability metrics, water and wastewater practitioners have developed alternative methods to better assess household affordability and identify potentially vulnerable populations within this context. Examples include:

- ***Socioeconomic analysis.*** First, it is important to gain an understanding of the socioeconomic characteristics of households within a utility service area. Key socioeconomic indicators include income levels, income distribution, poverty rates, and rates of public assistance/households receiving SNAP (food stamp) benefits, among others. Analyzing these data across household types and by neighborhood can help utilities identify potentially vulnerable populations and assess potential environmental justice concerns.
- ***Non-discretionary spending requirements.*** In addition to water costs, it is important to understand non-discretionary spending requirements, especially for low-income households. High costs for housing, other utilities, health care, and other basic needs can exacerbate water and wastewater affordability challenges for those with low or fixed incomes.
- ***Impact of household bills as a percentage of household income across the income spectrum, by geographic region, and household type.*** While EPA's RI looks solely at average water service costs per household as a percentage of MHI, it is helpful to evaluate water bills as a percentage of household income for different household types (e.g., renters, owners, elderly households) and at different income levels (e.g., at the 20th percentile, the lowest quintile income, LQI).
- ***Affordability ratio (AR)***. The affordability ratio (AR) is a relatively new household affordability metric that aims to capture the burden of basic costs of living by accounting for all essential expenditures that low-income households face to develop an estimated "discretionary income" for a household. Several different affordability ratios have emerged from different researchers including AR_{20}, AR_{PI}, AR_{MHI}, AR_{CPT}, and AR_{DP} (Teodoro 2018a, Feinstein 2018, Balazs et al. 2019); depending on the basis of the AR, various thresholds have been proposed to define what is considered affordable.
- ***Hours of minimum wage.*** Another metric, developed by Teodoro, is to equate the cost of basic water and sewer service to hours of minimum wage worked (Teodoro 2018b). This metric provides an alternative way to view and communicate about the impacts of water and sewer costs on local households.

Overview of Water Affordability Studies

Prior Explorations of Household Affordability

Because the related issues of household affordability and community financial capability are so fundamental to EPA (and state) regulatory and program implementation considerations, the methodologies used to assess impacts have been the subject of several prior reviews, summarized in Table 2.

Table 2. Prior reviews of affordability and financial capability methodologies (AWWA, NACWA, WEF Draft Report 2019).

Entity	Reference	Findings Summary
National Drinking Water Advisory Council	Recommendations of the NDWAC to EPA on Its National Small Systems Affordability Criteria (2003)	Affirmed use of MHI as the best metric available at the time but recommended an incremental impact threshold of 1% MHI for each rule to measure rate shock and recommended regional metrics to account for cost of living differences, while also raising several concerns about the approach to calculating the expenditure baseline. Finally, recommended more public education when variances are granted.
EPA Science Advisory Board	Affordability Criteria for Small Drinking Water Systems (2002)	Affirmed basic approach, calls to lower MHI% given lower quintile impacts, and guidance for local WQ variance reviews.
Environmental Finance Advisory Board	EFAB Analysis and Recommendations on: Draft Financial Capability Assessment Framework (2014) (Environmental Financial Advisory Board 2007)	Called for more expansive evaluation to consider all water resource utility service costs, cost of living measures and housing cost burdens. Noted need to modify financial indicators.
AWWA, USCOM, WEF	Affordability Assessment Tool for Federal Water Mandates (2013)	Recommended looking at Lowest Quintile Income (LQI) instead of MHI, all water sector service bills instead of CSO CPH, neighborhood level data, housing and other non-discretionary costs, poverty %, and additional socioeconomic indicators in place of the RI. For FCA the report recommends also looking at local tax revenues as a percent of gross taxable resources, unemployment severity, property tax collection rate, and other unfunded long-term liabilities such as pensions.
National Association of Clean Water Agencies	The Evolving Landscape for Financial Capability Assessment - Clean Water Act Negotiations and the Opportunities of Integrated Planning (2013)	Recommended three primary enhancements to EPA Integrated Planning Guidance-prescribed procedures; 1) watershed or triple bottom-line prioritization analyses, 2) cash-flow modeling analyses, and 3) analysis of disproportionate burden among customer classes.
National Academy of Public Administration	Developing a New Framework for Community Affordability of Clean Water Services (2017)	Recommended improvements to the EPA metrics include: (1) Use of publicly available data for transparent, straightforward, and reliable metrics; (2) Inclusion of all costs of water and use low-income rather than MHI; and (3) Determine the portion of utility customers that are most impacted.
AWWA, WEF, NACWA	Developing a New Framework for Household Affordability and Financial Capability Assessment in the Water Sector (Draft 2019)	Provides recommendations on household affordability metrics and assessment of utility wide financial capability. Recommendations include: (1) The Household Burden Indicator (HBI), including all water costs as a percent of the 20th percentile household income and (2) the Poverty Prevalence Indicator (PPI) for assessment of the prevalence of poverty in the community based on the portion of households with income <= 200% Federal Poverty Level (FPL).

Common themes of these reviews include the need to (1) consider economic burdens holistically as opposed to those related to a single utility service or compliance requirement; (2) gauge impacts for economically disadvantaged households, rather than focusing on median income levels; and (3) recognize differences in costs of living in different geographic settings.

Economic Feasibility Considerations: California Context

Affordability of water services is a challenge that is being faced by regulatory agencies at the state level. For example, in a recent California court case, the state's MCL for hexavalent chromium was voided because the judge ruled the state had failed to conduct the California SDWA's required analysis of the "economic feasibility" of the standard (Superior Court of California, County of Sacramento 2017). The judge went on to further state that**:** "Whether one uses the term "economically feasible" or the term "affordable," the court is concerned that some families will not have the income or resources to pay a water bill that increases by $5,600 per year. More important, the court is not convinced that the Department properly considered this fact when it adopted the MCL." (p 13).

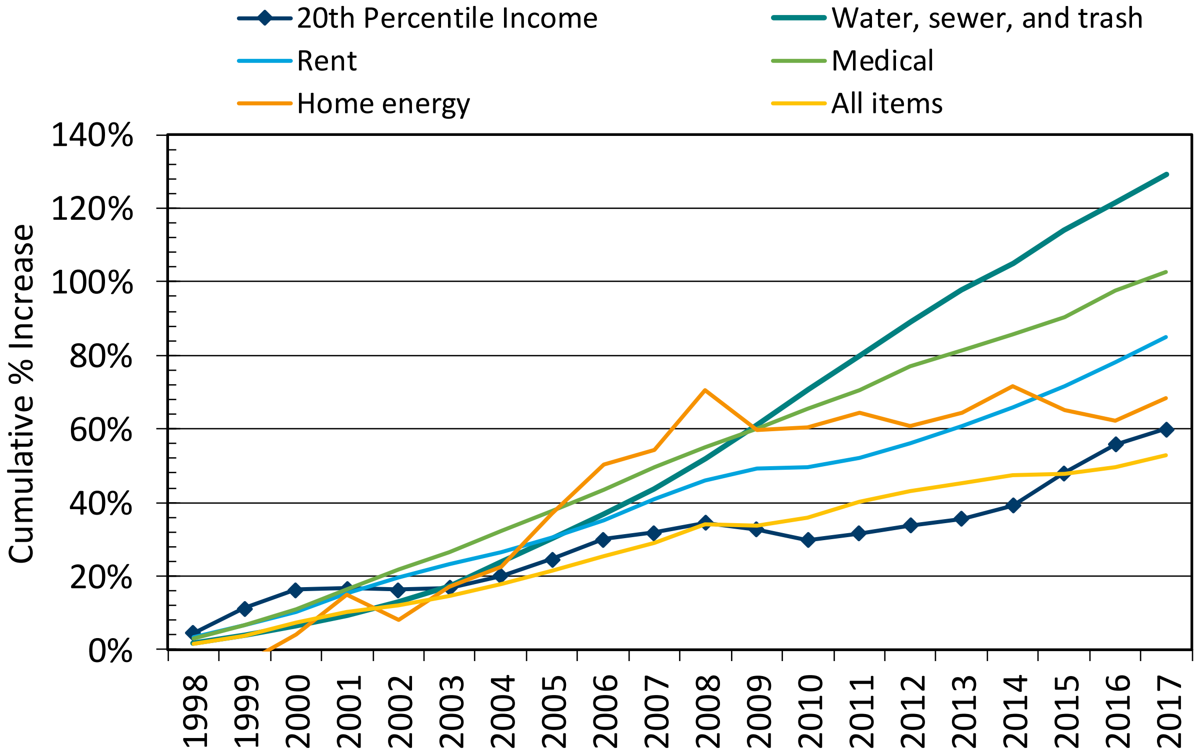
As a consequence of this ruling, the state currently is unable to revise or promulgate any new MCLs until it has effectively addressed what "economic feasibility" and "affordability" mean, and then develops an acceptable way of assessing whether a regulatory action conforms with these measures. The California EPA and State Water Resources Control Board are in the process of exploring how they can address this challenge.

Affordability Challenges: U.S. and California Households

In every community, there are customers who have difficulty paying their water and sewer bills (US EPA 2016). Per the U.S. Census Bureau American Community Survey (ACS), nearly 43 million people in the U.S. (13.4% of the U.S. population) lived below the federal poverty level (FPL) in 2017 (U.S. Census Bureau 2017a). Approximately 5.2 million of these individuals live in California, where the poverty rate in 2017 was 13.3% statewide. In addition, research shows that many households earning well above the poverty-level income have trouble paying for basic expenses (Gould et al. 2015). Federal, state, and local governments frequently set eligibility for social assistance programs at 150% or even 200% of the FPL. In both the U.S. and California, approximately 31% of the population earns less than 200% of the FPL; approximately 24% and 25% of U.S. and CA families, respectively, earn less than 200% of the FPL.

At the same time, the cost of basic necessities continues to rise. While growth in household incomes has outpaced the general rate of inflation over the last several years (even at the lower end of the income spectrum), it has not kept pace with increases in costs for many non-discretionary items. For example, as shown in Figure 3, the upper limit of the lowest quintile income (i.e., LQI, the 20th percentile household) increased by 60% over the last two decades. This is slightly greater than the increase in the CPI for all items, which grew by 52%. However, over the same period, costs for water and sewer increased by 129%, while the cost of rent, home energy, and healthcare increased by 85%, 68%, and 103%, respectively. This exacerbates the affordability challenge, as despite rising incomes, many households are finding it increasingly difficult to make ends meet.

Figure 3. Cumulative percentage increase in upper limit of the 20th percentile income household compared to increase in non-discretionary household expenditures and general CPI (Federal Reserve Economic Data 2017) .



In California, affordability challenges are exacerbated for low income households who face exceptionally high costs for housing, home energy, and other non-discretionary items. Table 3 shows cost of living indices for non-discretionary household expenditures in California, compared to a benchmark of 100 for the U.S. overall (Best Places to Live 2018). As shown, the cost of living in California is 69% higher than the U.S. average; however, this is primarily because of high housing costs. The data shown below indicate that households in California pay 193% more for housing than the average U.S. household. There is a large regional variation in housing costs as demonstrated by the housing cost index in El Centro (107.6) versus Santa Clara, California (755.2)(Best Places to Live 2018). At the same time, the MHI for California (2017) is only 19% higher than the MHI for the U.S. overall ($71,805 compared to $60,336) and the upper limit of the lowest income quintile (i.e., the 20th percentile income) is approximately 16% higher ($28,576 for California, compared to $24,625 for the U.S., a difference of close to $4,000).

Table 3. Cost of living index in California (Best Places to Live 2018).

Cost of Living Indices	El Centro, CA	Santa Clara, CA	California
Overall	99.7	310.5	169
Food & Groceries	107.8	110.8	107.2
Housing (Homeowner)	107.6	755.2	293
Utilities	101	86	102
Transportation	94.4	162	147
Health	87.9	93.7	93
Miscellaneous	94.9	104.6	104
MHI[1]	$43,581	$115,375	$71,805

[1] Santa Clara and California MHI from 2017 1-year ACS (U.S. Census Bureau 2017a), El Centro MHI from 5-year ACS (U.S. Census Bureau 2017b).

California is attempting to address the housing crisis through a series of legislative actions. In 2017 there were 15 housing-related bills signed into law. This was followed by another 16 bills that went in to effect on January 1, 2019 (Maclean et al. 2018). In 2018, voters passed Proposition 1, which supports housing programs for veterans, and Proposition 2, which uses taxes on millionaires to fund homelessness prevention for those with mental health issues (Ballotpedia 2018a, 2018b). The trend in housing bills appears poised to continue in the 2019 legislative session (Abell 2018).

Poverty in California

A discussion about water affordability is not complete without acknowledging the bigger issues of poverty in California. The US Census Bureau measures poverty in two ways. One is the official poverty measure and the other is the Supplemental Poverty Measure (SPM), which accounts for costs like housing and medical expenses and benefits like the Supplemental Nutrition Assistance Program (SNAP). California has an SPM of 19%, compared with a national average of 14.1% (Fox 2018). California is tied with Florida and Louisiana for highest SPM poverty rate in the US (Caiola 2018).

Causes of Poverty

The causes of poverty are complex and not easily linked to one factor alone. Entire books have been written on this topic, which we will not delve into in this report. What follows is a basic outline of the factors that can contribute to poverty which are summarized from a course titled Poverty 101 (Haveman 2013):

- Labor market issues – low wages and unemployment both contribute to poverty. These conditions are linked to the broader labor market, so economic downturns are correlated with an increase in poverty.
- Education – lower levels of education are associated with higher rates of unemployment and lower wages. For example, an educational attainment of less than High School leads to poverty rates of 35%, while educational attainment of a bachelor's degree or higher leads to poverty rates of 5%. Real wages have decreased for workers with a High School diploma or less from the 1970's through 2010.
- Demographics of families – single parent households are at higher risk for slipping into poverty. For example, in 2011 single mother households had a 40.7% poverty rate, which is a decrease from the 59.9% poverty rate in 1959 for the same group.
- Race – blacks and Hispanics had poverty rates over 25% in 2010, while Asians had a poverty rate over 10%, and whites had a poverty rate just under 10%. While the poverty rate for children in

the US is 21%, it is 46% for black children and 40% for Hispanic children. Much of the income difference is due to lower education levels, however some studies show that part of the difference is due to wage discrimination.

One additional factor leading to poverty is our incarceration system. Once someone has been incarcerated, they are barred from the anti-poverty programs that could help them to re-integrate into society. It can also be very difficult for these same people to find a job leading to recidivism, poverty, and homelessness (Friends Committee on National Legislation 2017). Between 25 and 50% of the homeless population has been incarcerated (Knopf-Amellung 2013). There is also newer research showing that poverty is associated with incarceration. For example black men who were incarcerated made 44% less, prior to incarceration, than un-incarcerated black men (Rabuy & Kopf 2015). The policies that were designed to be tough on crime have created a cycle of poverty and imprisonment (Rabuy & Kopf 2015).

Policies Addressing Poverty

Similar to the previous section on the causes of poverty, there is extensive literature about the policies addressing poverty, a full discussion of which is outside of the scope of this paper. What follows is a basic outline of the policies designed to address poverty which are summarized from a course titled Poverty 101 (Haveman 2013):

- Cash welfare [Temporary Assistance of Needy Families (TANF)], Supplemental Nutrition Assistance Program (SNAP) formerly referred to as food stamps, Medicaid, subsidized housing, special supplemental nutrition program for Women, Infants, and Children (WIC), free or reduced-price lunch, Earned Income Tax Credit (EITC), minimum wage, unemployment insurance, and social security.
- EITC is a tax credit for working low income people. It is more generous for families with children than families without children. It is estimated that the EITC lowered the overall poverty rate by 2.5% in 2011 and it helped reduce child poverty by 5.5%.
- TANF (welfare) helps those that are not working, but the benefit level is so low that it is unlikely to raise a family out of poverty.
- In the late 1990s there was major reform in the TANF program and there was an expansion in the EITC. This led to increases in employment of single mothers, which did reduce poverty for this group.

Health Impacts of Poverty

Households who struggle to meet basic needs face significant tradeoffs in the allocation of their budgets. For example, small increases in rent or water and sewer bills can adversely affect a households' ability to pay for needed food, heat, and medical care (Raucher et al. 2011). Beyond these direct tradeoffs, United Way's Consequences of Insufficient Household Income report explores how Asset Limited, Income Constrained, Employed (ALICE) and poverty-level families manage when they do not have enough income or assistance to meet basic needs (United Way 2017). In California, 48% of households are living below the ALICE threshold making it one of the highest in the nation (United Way 2018). The authors found that "the larger the gap between income and costs, the more extreme the strategies, and the greater the risks to a family's immediate health and safety. These strategies have consequences for a family's employment, for where they live, for what they eat, and for how their children fare in school." In addition, these choices affect many beyond the immediate household by reducing economic productivity, stressing local health care and education systems, and raising insurance premiums and taxes for everyone (United Way 2017).

There are many negative health impacts of living in poverty including higher rates of obesity, diabetes, and cancer (Freeman 2004, American Cancer Society 2011a, Levine 2011). In men there are 91.94 excess cancer deaths per 100,000 when the least educated group (less than or equal to 12 years) is compared to the most educated group (greater than or equal to 16 years) (American Cancer Society 2011b). If poverty were regulated like a drinking water contaminant then we would have to take action to reduce it. Addressing the drinking water violations in a system does not alleviate the underlying health disparities between those living in poverty and those in other income brackets.

Minimum Wage

As of January 1, 2018 the minimum wage in California is $11 per hour and is increasing by $1 per hour every year through 2022 for employers with more than 26 employees (Department of Industrial Relations 2016). Smaller companies have a one-year delay in implementation. There is no statewide mandated variation in minimum wage based on the cost of living in a given area. Although, some cities like San Francisco have elected to have a higher minimum wage of $15 per hour as of July 1, 2018 (City of San Francisco, Office of Labor Standards Enforcement n.d.). Table 4 shows how increasing the minimum wage by 2022 could theoretically impact earnings for households with minimum wage workers.

Table 4. Minimum wage comparison.

Hourly wage	Annual salary 1 worker	% statewide MHI	Annual salary 2 workers	% statewide MHI	Over or under 200% FPL for a family of 4
$ 11 (2018)	$22,880	31%[1]	$45,760	62%[1]	Under
$ 15 (2022)	$31,200	37%[2]	$62,400	75%[2]	Over

[1] In 2018 dollars assuming a 3% inflation rate (MHI of $73,959 and 200% FPL of 50,200)

[2] In 2022 dollars assuming a 3% inflation rate (MHI of $83,242 and 200% FPL of 56,501)

The increasing minimum wage can lift a family of 4 with two minimum wage workers above the 200% of the FPL cutoff, and can bring a family with 2 adults working at minimum wage much closer to the statewide MHI level.

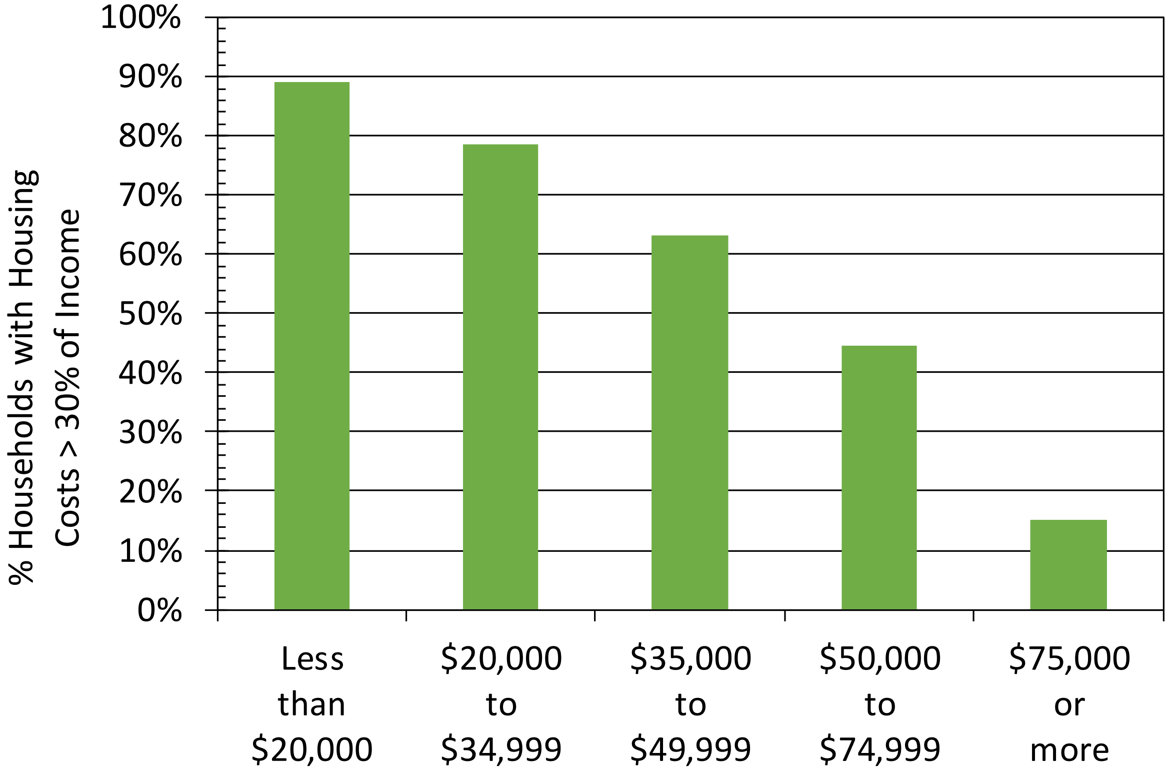
There is debate among economists about the impact of minimum wage on the number of jobs. Some economists argue that increasing minimum wage will cause a loss of jobs and will increase unemployment among the poor (Neumark et al. 2013, Wolla 2014). However, several case studies demonstrate that there is not a negative an impact in the number of jobs when minimum wage is increased (Card 1992, Card & Krueger 1993, Dube et al. 2010, Cengiz et al. 2017).

One cause of poverty is unemployment, so an increase in minimum wage will not help households enduring poverty as a result of no employment (Haskins 2017).

Housing Cost and Shortage

Although wages are higher in California, as mentioned above, housing costs are disproportionately higher, particularly in the San Francisco Bay Area and the Los Angeles Area. High housing costs exacerbate the challenges faced by households in poverty. For housing to be considered affordable, it should account for not more than 30% of a household's income (HUD n.d.). As shown in Figure 4, many households in California have a high housing burden, meaning they pay more than 30% of their income for housing. In 2015, 8 out of 10 low-income households in California, as defined by 200% of the FPL, were in unaffordable housing, meaning that they were spending more than 30% of household income on housing (Kimberlin 2017). In comparison, based on 2017 ACS 5-Year Census data, the percent of households paying more than 30% of income for housing and earning less than $50,000 was 77% statewide.

Figure 4. Percent of California households with housing costs greater than 30% of household income by income category (2017 U.S. Census ACS 5-Year (2013 – 2017)).



In California the housing shortage is the key factor in rising housing costs. Real estate prices in California have risen three times faster than income (Woetzel et al. 2016). This resulted in 4 out of 10 households paying more than 30% of the household income for housing in 2015, with renters disproportionally impacted compared to home owners (Kimberlin 2017). From 2009 to 2014 California added over 540,000 households, but only 467,000 housing units. As of 2016, California has 2 million fewer housing units than it needs (Woetzel et al. 2016). Development has been limited by high cost to develop, high regulatory burden, and slow approval processes. A detailed discussion of the causes and potential solutions to the California housing shortage is discussed in the McKinsey Global Institute report titled *A Tool Kit to Close California's Housing Gap: 3.5 Million Homes by 2025* (Woetzel et al. 2016).

Current Water Affordability Efforts in California

Investor-owned Utility Water Subsidy Programs

It is important to have the context of low-income subsidies that exist at the customer level. The large investor owned drinking water utilities in California have subsidy programs in place for low-income customers. These programs are often referred to as Customer Assistance Programs (CAPs). Investor owned utilities are regulated by the California Public Utilities Commission (CPUC), which approved the programs summarized in Table 5. Funding is provided by a small charge on customer bills. Families that qualify for the CAPs do not pay into the subsidy fund.

Table 5. California investor owned utility low income subsidy programs.

Utility	Program name	Program Website
California Water Service	Low-Income Rate Assistance (LIRA)	https://www.calwater.com/community/lira/
California American Water Company	H2O Help to Others Program	https://amwater.com/caaw/customer-service-billing/low-income-program
Golden State Water Company	California Alternate Rates for Water (CARW)	https://www.gswater.com/carw/
Great Oaks Water Company	Low-Income Customer Assistance Program (LICAP)	No dedicated website
Liberty Utilities	California Alternative Rates for Water (CARW) Program	https://california.libertyutilities.com/apple-valley/residential/my-account/my-bill/programs/carw-program.html
San Gabriel Valley Water Company	California Alternative Rates for Water (CARW) Program	https://www.sgvwater.com/customer-services/program-services/california-alternative-rates-for-water-carw/
San Jose Water	Water Rate Assistance Program (WRAP)	https://www.sjwater.com/customer-care/help-information/water-rate-assistance-program
Suburban Water Systems	Water Invoice and Statement Help (WISH) Program	https://www.swwc.com/suburban/wish/

As an example, additional details are provided here for the California Water Service (Cal Water) Low-Income Rate Assistance (LIRA) program. The program is funded through customers that are not enrolled in LIRA paying between $0.24 and $0.41 per month as a flat rate surcharge (Pacific Institute & Community Water Center 2013). This money goes into a fund that is used to subsidize the bills of low-income customers. Under the Cal Water LIRA program, customers can qualify for an average of $7 per month bill subsidy (Pacific Institute & Community Water Center 2013). Table 6 is an example showing the maximum household income that qualifies for the Cal Water LIRA program. If a customer is already qualified for the low-income subsidy available from Pacific Gas and Electric (PG&E), then the household is automatically enrolled in the LIRA program. Both the PG&E program and the Cal Water program use 200% of the Federal Poverty Level (FPL) as a threshold for qualification. At this point there is not a different income limit in different parts of the state.

Table 6. Income limits for Cal Water LIRA program

Household Size	1-2	3	4	5	6	7	8
Total Combined Annual Income	$32,920	$41,560	$50,200	$58,840	$67,480	$76,120	$84,760

Another feature of the LIRA program is the Bathroom Fixture Replacement Program. The utility pays for labor and parts to replace bathroom fixtures such as toilets and showerheads for any residential customer enrolled in LIRA (US EPA 2016). By using low flow fixtures the customers will save water and money. Usually water conservation programs that pay for water saving fixtures are rebate programs, which can limit the participation of low-income customers due to the initial investment required (US EPA 2016). Since the bill must be in the name of the eligible customer, many renters in apartments cannot enroll in the program, although they may meet the income requirement ("Low-Income Rate Assistance (LIRA) - Cal Water" n.d.).

Other Affordability Programs in California

Some Californian cities and water districts provide CAPs for low income customers; examples of these programs are summarized in Table 7. Many programs use the same income requirements as the statewide California Alternative Rates for Energy (CARE) program, which is 200% of the FPL.

Table 7. Non-investor owned utility CAPs.

Utility	Program Name	Overview	Average Subsidy	Reference
City of Napa	RateShare Discount	Low income single family residential customers with income below 200% of the FPL.	$25/ bimonthly water bill	(City of Napa n.d., Pacific Institute & Community Water Center 2013)
City of Sacramento	Salvation Army Family Services	One-time assistance for qualifying customers. Funding provided by the Salvation Army.	Up to $200	(The Salvation Army n.d., Pacific Institute & Community Water Center 2013)
East Bay MUD	Customer Assistance Program	Provides subsidies to low income customers and homeless shelters.	Up to 50% off of service charge and water use charge.	(Pacific Institute & Community Water Center 2013, EBMUD 2018)
San Francisco Water, Power and Sewer	Community Assistance Program	Required to have a free water conservation evaluation. Income below 200% of FPL.	15% discount on water and 35% discount on sewer charges	(San Francisco Water Power Sewer n.d., Pacific Institute & Community Water Center 2013)

Proposition 218, which was approved by California voters in 1996, contains a restriction that applies to subsidy programs for municipal and other publicly owned systems. In cities and water districts the water charges cannot exceed the cost of service, which means that a fee cannot be collected from higher income customers to subsidize lower income customers (California Special Districts Association 2013). In order to avoid conflict with Proposition 218 these programs are funded by non-rate payer revenue. For example, the City of Sacramento program is funded by the Salvation Army, while the EBMUD program is funded by non-enterprise money, such as property tax.

SWRCB Subsidy Program Plan

In 2015 the Low-Income Water Rates Assistance (LIWRA) Act became law (Bonilla 2015). This bill requires the SWRCB to prepare a plan to fund and implement a LIWRA program (SWRCB 2018). The SWRCB contracted with the University of California, Los Angeles to study the cost of statewide implementation of this type of subsidy program. Major findings of the study are summarized below (Pierce 2017):

- In 2015 $1.3 Billion was spent on the California Alternate Rates for Energy program
- 34% of people in California are below 200% of the FPL [1]

[1] Reported here, the 34% of Californians below 200% of the FPL is based on the 5-Year ACS data for California (U.S. Census Bureau 2017b). Earlier in the report, the listed 31% of Californians below 200% of the FPL is based on the 1-Year ACS data for California (U.S. Census Bureau 2017a).

- Using 200% of the FPL as the threshold for qualification, in over 20% of CA water systems, half of the households would qualify
- Assuming a subsidy of 20% on a bill for 1,200 cubic feet (12 CCF) of water per month, about $580 Million per year would be needed to fund the subsidy statewide
- In the study, $301 Million of the subsidies would be for customers that are currently in a CAP program, while $279 Million would be for customers served by systems without a LIRA program.

The SWRCB released the associated Draft report on January 3, 2019 along with a Notice of Opportunity for Public Comment, with comments due by February 1, 2019 (SWRCB 2019b).

National Examples

Case studies of CAPs from across the nation have been compiled in several studies; a summary of national CAPs is provided in Table 8.

Table 8. Summary of national Customer Assistance Programs.

Utility	Program Name	Overview	Average Subsidy	Reference
North East Ohio Regional Sewer District, Ohio	Homestead Rate Program	For those over 65, or permanently disabled with an annual income less than $32,000 (in 2015)	$315/year	(US EPA 2016)
North East Ohio Regional Sewer District, Ohio	Wastewater Affordability Program	For households at or below 200% FPL	40% rate reduction	(US EPA 2016)
North East Ohio Regional Sewer District, Ohio	Crisis Assistance Program	For households that experience a major crisis such as medical, job loss, divorce, or death of a household member. Can only use once in a 12-month period.	Up to 50% credit on amount owed (up to $300)	(US EPA 2016)
Orange Water and Sewer Authority, North Carolina	Care to Share	Funded by voluntary donations.	Not stated	(US EPA 2016)
San Antonio Water System, Texas	Affordability Discount	Households below 120% FPL.	$4-$15 discount/ month	(US EPA 2016)
San Antonio Water System, Texas	Project Agua	One-time payment assistance for customers who are facing water shut-off.	Average of $100	(US EPA 2016)
Washington Suburban Sanitary Commission, Maryland	Water Fund Program	Funded through donations. For customers	Maximum of $300 / 12-month period	(US EPA 2016)
Washington Suburban Sanitary Commission, Maryland	Customer Assistance Program	Ratepayer financed, which required a law change. Four households below the FPL.	$37/ quarter discount	(US EPA 2016)
New York City Environmental Protection, New York	Home Water Assistance Program	Provided to over 50,000 homeowners that make less than $50,000 per year.	Credit of $115.89 applied in 2018.	(NYC Environmental Protection 2018)
New York City Environmental Protection, New York	Multi-family Water Assistance Program	Provided to customers in affordable multi-family housing.	Credit of $250 per year for each residential unit	(NYC Environmental Protection 2018)
City of Atlanta Department of Watershed Management, Georgia	Care and Conserve	Households below 200% of the FPL + $500	Leak vouchers of up to $3,000 and temporary bill paying assistance of up to $1,000, plumbing assistance	(Berahzer et al. 2017)

Camden County Municipal Utilities Authority, New Jersey	Host Community Benefit	Benefit provided to all residence of Camden, many of which are low-income.	$132/year discount	(Berahzer et al. 2017)
Great Lakes Water Authority and the City of Detroit Water and Sewerage Department, Michigan	Water Residential Assistance	For eligible low-income residential customers.	Provides $25/ month for a year, forgives up to $700 of past due amounts, up to $1,000 in minor plumbing repairs	(Berahzer et al. 2017, Blake et al. 2017)
City of Portland Water Bureau	Bill assistance	For eligible low-income residential customers.	Provides a discount of $142.04/ 90-day bill on water and wastewater	(Berahzer et al. 2017, Blake et al. 2017)
City of Raleigh Public Utilities Department, North Carolina	Utility Customer Assistance	Customers must have incomes below 130% of the FPL and be overdue on payment.	Provides $240 in one-time assistance.	(Berahzer et al. 2017)
City of Seattle Public Utilities, Washington	Utilities Discount	For customers with income at or less than 70% to the statewide MHI.	Provides a discount of 50%	(Berahzer et al. 2017)
City of Seattle Public Utilities, Washington	Emergency Assistance	For single family customers.	Up to $392 off of unpaid bills	(Berahzer et al. 2017)
DC Water and Sewer Authority, District of Columbia	Customer Assistance	The qualifications for the program are the same as the federal Low-Income Heating and Energy Assistance Program.	Provides credit for 3,000 gallons/ month which is about $38/month	(Berahzer et al. 2017)

One important consideration for CAPs is what to do about "hard to reach" low-income households. These households are water system users that may meet the income requirement for a CAP program but do not directly receive a water bill (i.e., they are not directly "customers" of the utility) because they reside in multi-family residential units which have only one bill for the entire complex, or are single-family renters who pay for water and other utilities as part of their rent. This has been a topic of research nationally, and the hard to reach population can be a significant portion of the low-income customers served by utilities (Clements et al. 2017). The most effective way to reach these customers is to partner with existing trusted organizations that already work with hard to reach customers (Clements et al. 2017).

New York City has a good example of a multi-family CAP. They partner with the City Department of Housing Preservation and Development and also the Housing Development Corporation to identify affordable multi-residential units that qualify as affordable (NYC Environmental Protection 2018). The landlord receives an annual credit of $250 per unit if they agree to keep the rental unit as affordable housing for a given number of years, which encourages affordable housing in the city. The buildings must show that they have achieved water conservation targets to qualify for the subsidy (NYC Environmental Protection 2018).

Challenges with Existing Low-income Water Subsidy Models in California

Although the existing subsidy programs do help some low-income customers, there are some remaining challenges with the California models. These programs are only available to customers in systems that have a subsidy program, which typically are limited to investor owned utilities (IOUs). Rate-payer based subsidy programs would not work in small economically disadvantaged systems, where there are not enough higher income customers to subsidize the low-income customers. This issue is mirrored at the national level as summarized in Table 8, where all of the programs that have been featured as case studies are relatively large systems.

Proposition 218 restricts the ability of cities and water districts (i.e., those that are not IOUs) to collect a fee for anything unrelated to services provided. This effectively restricts the way that CAPs can be funded (California Special Districts Association 2013). Cities and water districts that have low income subsidy programs can use other sources of revenue, such as income derived from cell tower leases or voluntary contributions to fund the program (Modica 2014).

Not all customers that qualify for CAPs are enrolled. For example, the low-income, hard to reach customers, that either live in multi-family units sharing a meter or are single family residence renters with water bills included in the rent, are not receiving a subsidy and on average account for 40% of low-income customers (Clements et al. 2017). Low-income customers that are in single family houses may not be enrolled in a CAP program because they are unaware of its existence. Even a 20% water bill subsidy may not make water affordable. This issue will be discussed further in the section detailing the Affordability Assessment for the participating utilities. It is worth noting that using systemwide subsidies for capital and operational and maintenance costs avoids the challenge of identifying and subsidizing the hard to reach customers. Systemwide subsidies inherently keep bills from rising for all customers, including those that are low-income.

Further, the existing CAPs in California fail to account for the variability in regional income and housing costs. In areas with expensive housing, customers that are effectively low income would not qualify as low-income using the 200% FPL cut-off. These low-income customers may be paying into the CAP program because of the lack of housing (and other essential) cost considerations in existing CAPs.

California Funding Options

In 2018, Proposition 68 was passed by voters, providing additional funding for drinking water projects (Ballotpedia 2018c). The details of how this new funding will be implemented are not yet available. In 2014, Proposition 1, a $7.545 Billion water bond, was passed by California voters. Prop 1 funds are administered by the State Water Resources Control Board (SWRCB) and $260 Million are appropriated to drinking water projects (State of California 2016). These funds can be used for planning and construction of capital improvement projects. Depending on the economic status of the water system the funding may be a loan, a loan with principal forgiveness, or a grant. A few definitions are helpful at this juncture:

- Economically disadvantaged communities (DACs) are defined as having an MHI of 80% or less than the statewide MHI (Tran 2015).
- Severely economically disadvantaged communities (SDACs) are defined as having an MHI of 60% or less than the statewide MHI (Tran 2015).
- Small systems are those with a population of 10,000 or less.

Priority for funding is given to small and economically disadvantaged systems. Loan forgiveness is available to DAC and SDAC systems.

Previously, Proposition 50 was passed by voters in 2002 and voters approved Proposition 84 in 2006. The funding levels associated with all of the water related Propositions are summarized in Table 9.

Table 9. California Propositions providing funding to drinking water projects.

Proposition	Year approved	Total funding	Drinking water funds	Other funds available related to drinking water
50	2002	$3.440 Billion	$435 Million	$100 Million
84	2006	$5.388 Billion	$1,495 Million	
1	2014	$7.545 Billion	$260 Million	$25 Million
68	2018	$4 Billion	$250 Million	$80 Million

With rare exception, this funding is reserved for capital and capital planning expenditures which is a challenge for systems that cannot afford the ongoing operations and maintenance expenses associated with treatment. During the 2017 and 2018 legislative session, Senate Bill 623 was proposed to create a dedicated fund for subsidizing the operational and maintenance costs in drinking water systems that qualify (DeLeon & Hertzberg 2017). The bill was not brought for a vote during 2018 but may return in 2019.

In the section of this paper devoted to the affordability in the three systems participating in this project, the need for operational and maintenance funding to make treatment affordable will be demonstrated.

When Paying for Capital is Not Enough

In 2007 an arsenic treatment plant was built in Lanare Community Services District, in Lanare California, using $1.3 Million in funds from the Community Development Block Grant (Kemp 2008, Romero & Klein 2017). According to a 2018 income survey, the MHI in Lanare is $30,000, which is 47% of the statewide

MHI, qualifying Lanare as an SDAC (Kings Basin Water Authority 2018). The system has 147 connections and a population of just under 600 (Kings Basin Water Authority 2018).

The arsenic treatment installed was coagulation filtration with pH adjustment and ferric addition (Wathen 2018). Treatment began in November of 2006 (Kemp 2008). Unfortunately, the operations and maintenance expenses were not originally accounted for and about $100,000 in debt was accrued in about six months before treatment was discontinued (Romero & Klein 2017). Issues that contributed to the failure of the Lanare project are summarized below:

- Fresno County was the Local Primacy Agency (LPA) that regulated Lanare at the time of treatment installation. The County lacked staff that was well-versed in highly technical treatment systems.
- Water demand was higher than expected after installation of treatment than before treatment (Kemp 2008).
- Illegal irrigation connections were a possible contributing factor (Kemp 2008).
- Operations and maintenance costs were not accounted for in rates prior to capital installation (Wathen 2018).

The increase in the water bill that would be required to pay solely for the operation and maintenance expense associated with treatment is about $113 per month, which is 4.5% of the MHI of the residents in Lanare. Once the existing water bill of $50 per month is accounted for, the total water bill would represent 6.5% of the MHI. That is not considered affordable by any standard metric.

The current plan in Lanare is to drill two new grant funded wells (Romero & Klein 2017).

After the announcement of the federal arsenic MCL reduction to 10 µg/L in 2001 there was a rush to install new treatment technologies. In some cases, the utilities did pilot testing which demonstrated that the adsorptive medias have variable performance due to the water quality; for example, phosphate and silica were found to interfere with arsenic removal (California Water Service 2004, Walsh 2011, Nguyen et al. 2011, Kanematsu et al. 2012). Build-up of arsenic and other compounds, such as vanadium can require the spent media to be disposed of as hazardous waste, which is much more expensive to dispose of (California Water Service 2004, Chen Wei-Hsiang et al. 2010).

Lessons Learned

There are several lessons learned from these treatment failures, which are summarized below:

- Examine all solutions, including non-treatment solutions. The option with the lowest long-term O&M must be given serious consideration.
- Account for O&M expenses in planning phase.
- Pilot test new technologies.
- Have strong performance guarantees in contracts with vendor.

Part 2: Affordability Considerations

As described above, there are many factors to consider in the assessment of the affordability of drinking water in California. This section details the components of our assessment of the affordability of treatment for the three participating utilities. Key components include:

- Collection and compilation of community and water system details: Income, population, location, cost of living, system boundaries, census data, etc.
- Treatment costs: Capital equipment, installation, and ongoing O&M costs
- Affordability metrics: Affordability thresholds, measurement of costs relative to income, etc.

Affordability metrics and data sources are further detailed below, and treatment costs are discussed in the next section.

Selected Affordability Metrics

The project team used the following methods and metrics to assess the affordability of drinking water and nitrate treatment for the participating systems:

Socioeconomic Analysis. First, it is important to gain an understanding of the socioeconomic characteristics of households within a utility service area. Key socioeconomic indicators include income levels, income distribution, and poverty rates, among others.

Non-Discretionary Spending Requirements. In addition to water costs, it is important to understand non-discretionary spending requirements, especially for low-income households. High costs for housing, other utilities, health care, and other basic needs can exacerbate water and wastewater affordability challenges.

Percentage of Household Income. This metric evaluates the impact of household bills as a percentage of household income. While EPA's RI looks solely at average residential wastewater service costs per household as a percentage of MHI, it is helpful to evaluate water and wastewater bills as a percentage of household income at different income levels; evaluating the percentage of income that households pay for water at the 20th percentile household income [Lowest Quintile Income (LQI)] level can inform our assessment of affordability for lower income households in the community.

Household Burden Indicator and Poverty Prevalence Indicator. Two new metrics have been proposed in the latest Draft report from AWWA, NACWA, and WEF: the Household Burden Indicator (HBI) and the Poverty Prevalence Indicator (PPI) (AWWA, NACWA, WEF Draft Report 2019). The HBI is the cost of basic water services for 50 gallons per capita per day (gpcd), including drinking water and wastewater, as a percent of the 20th percentile household income (LQI). The PPI provides assessment of the prevalence of poverty in the community based on the portion of households with income ≤ 200% FPL. The HBI and the PPI are intended as joint metrics to be interpreted together in a matrix approach as illustrated below (Table 10). The numeric values shown for the HBI benchmark levels are preliminary, and subject to revision based on future empirical investigation. There are two primary factors to be considered with regard to the HBI thresholds:

(1) The values shown are based on pivoting from U.S. EPA's 4.5% of MHI as a combined water and wastewater affordability threshold; a more suitable MHI-oriented benchmark may be more appropriate as a basis for calculating a comparable percentage of LQI; and

(2) The numerator in U.S. EPA's 4.5% calculation uses total water sector costs assigned to residential customers, rather than the actual cost of "basic" water needs, which is the basis used for HBI.

Table 10. Affordability benchmark matrix based on Household Burden Indicator (HBI) and Poverty Prevalence Indicator (PPI). Excerpted from (AWWA, NACWA, WEF Draft Report 2019).

HBI – Water Costs as a Percent of Income at LQI	PPI – Percent of Households Below 200% FPL		
	≥ 35%	20% to 35%	< 20%
≥ 10%	Very High Burden	High Burden	Moderate-High Burden
7% to 10%	High Burden	Moderate-High Burden	Moderate-Low Burden
< 7%	Moderate-High Burden	Moderate-Low Burden	Low Burden

Affordability Thresholds. Different organizations have proposed thresholds for marking what is and is not affordable (Table 11). As previously discussed, it is generally accepted that the US EPA benchmark for what is considered to be an affordable drinking water bill is 2.5% of small community MHI (AWWA, USCM, WEF 2013). This threshold is further supported in the context of National Primary Drinking Water Regulations; the US EPA "determines the affordability of a rule … where [the] Affordability Threshold is the upper limit for the cost of water bills including costs for treatment, distribution, and operation (the current Affordability threshold is 2.5% of Median Household Income -- MHI)"(US EPA 2002).

Table 11. Affordability thresholds for water costs.

Affordability Threshold	Water Services	Organization
1.5% of MHI	Drinking Water	CA State Water Resources Control Board (SWRCB 2016)
2.5% of MHI	Drinking Water	US Environmental Protection Agency (USEPA) (US EPA 2002)
3% of MHI	Drinking Water	United Nations Development Program (UNDP) (UNDP 2014)
2% of MHI	Wastewater	US Environmental Protection Agency (US EPA 1997)
4.5% of MHI	Drinking Water and Wastewater	US Environmental Protection Agency (US EPA 2002) US Environmental Protection Agency (US EPA 1997)
7% – 10% of LQI[2]	Drinking Water and Wastewater	(AWWA, NACWA, WEF Draft Report 2019) (AWWA, NACWA, WEF Draft Report 2019)

In California, the threshold for what is considered to be an affordable drinking water bill is 1.5% of MHI. The 1.5% benchmark was included in Section 116760.50 of the California Water Code in 2017 (AB 560), in which unaffordable water rates were described as an "average water bill that is at least 1.5 percent of the median household income of the service area or other percentage that the board determines is appropriate to reflect funding priorities" (California Code, Health and Safety Code - HSC § 116760.50 2017). Section 116760.50 has since been amended, excluding mention of what is and is not considered affordable. The 1.5% threshold has also been listed by the SWRCB as a benchmark for funding for DACs and SDACs elsewhere (SWRCB 2016). Most recently, similar thresholds were included in the permanent

[2] According to AWWA, NACWA, and WEF (Draft Report), "…it is recommended that a benchmark of about 10% of LQI serve as an interim demarcation that indicates that total water services are highly burdensome and not affordable. It is also recommended that if combined water costs are between 7% and 10% of service area LQI, then the water costs should be deemed as high burden, and potentially unaffordable" (AWWA, NACWA, WEF Draft Report 2019). As mentioned previously, the numeric values shown for this affordability threshold are subject to revision based on future empirical investigation.

regulations pertaining to POU and POE treatment regarding the economic feasibility of installing centralized treatment; a threshold of 1% of MHI for the costs of centralized treatment, 1.5% of MHI for the cost of treatment plus a recent water bill for communities with MHI below the California MHI, and 2% of MHI for the cost of treatment plus a recent water bill for communities with MHI above the California MHI (SWRCB 2019a).

Affordability Ratios (AR). Several variations on the AR have been proposed; the range of ARs are discussed below and summarized in Table 12.

The affordability ratio (AR) is a relatively new affordability metric that aims to capture the burden of basic costs of living by accounting for all essential expenditures that low-income households face. The above described percentage of household income is similar to the ARs discussed below; however, the below ratios are based on discretionary income rather than total income and basic water use rather than average water use.

Texas A&M University, Manuel Teodoro (2018)

The AR introduced by Teodoro (2018a) compares the cost of water and sewer service for a level of reasonable basic use (defined as 50 gallons per capita per day, gpcd)[3] to after-tax household income less essential costs, including food, shelter, health care, and home energy. The ratio is typically applied to the upper limit of the lowest income quintile (i.e., the 20th percentile income level, in which case it is labeled as the AR_{20}) but can be applied at various income levels. In addition to accounting for non-discretionary spending requirements among low-income households, the AR allows utilities to assess affordability based on basic water use, rather than on total water use, which can include significant irrigation and other outdoor uses.

Defining basic use for the affordability ratio (AR)

In developing the AR methodology, Teodoro (2018a) defines basic use as 50 gallons per person per day (gpcd). The author notes that the 50 gpcd standard "is a typical assumed minimal residential wastewater flow for purposes of sewer system design (Bowne et al. 1994), and is meant to reflect indoor, non-discretionary water use to maintain health in a contemporary American home." In addition, Teodoro (2018a) reasons that while it is significantly less than average consumption of 91 gpcd reported by (DeOreo et al. 2016) (Water Research Foundation Residential End Uses of Water Study), it is greater than the 35.6 gpcd standard that Chenoweth (2008) identifies as the "minimum water requirement for social and economic development." Thus, 50 gpcd represents a reasonable, conservative level of basic service for purposes of evaluating affordability across large numbers of utilities. Following his methodology, we assume 50 gpcd as the basic level of usage for developing AR-related metrics.

Pacific Institute, Laura Feinstein (2018)

Recent work by the Pacific Institute presents a framework of service indicators and performance measures to assess drinking water and sanitation in terms of water safety, water affordability, and water accessibility (Feinstein 2018). With respect to affordability, the Pacific Institute's AR (referred to here as AR_{PI}) considers the average water and wastewater bill for per household for 43 gpcd relative to discretionary household income, where discretionary income is household gross income minus expenses on shelter, health care, food, transportation, telephone, laundry and cleaning, home energy, and taxes.

[3] Teodoro assumes 50 gpcd as a reasonable level of use to support health, sanitation, and basic household uses.

The Pacific Institute proposes collective assessment of system-level affordability based on the portion of households spending more than a pre-determined satisfactory amount of income on water.

The Pacific Institute (Feinstein 2018) - System Level Affordability

"For the System-Level Performance Measure…we consider a system in which half or more of its customers spend more than 10% of their discretionary income on water as Unacceptable. When at least half the ratepayers are heavily burdened by the cost of water, it is a strong indication that systemic reforms should be considered to bring the cost of water in line with what the community can afford to pay. We suggest that a system in which 40% to 50% of households spend more than 10% of discretionary income on water would be considered Marginal, 33% to 40% would be Moderate, and less than 33% would be Satisfactory."

Office of Environmental Health Hazard Assessment (OEHHA), Carolina Balazs et al. (2019)

Most recently, the Office of Environmental Health Hazard Assessment (OEHHA) has released a draft report providing a framework for assessing the quality, affordability, and accessibility of drinking water; the framework is intended as "a tool to track changes and needs across the state's community water systems and across the framework's three principal analytic components – water quality, accessibility, and affordability" (Balazs et al. 2019). Balazs et al. discuss several different affordability ratios, AR_{MHI}, AR_{CPT}, and AR_{DP}, corresponding with the affordability ratio based on (1) MHI, (2) the county poverty threshold (CPT), and (3) one half of the county poverty threshold to represent deep poverty (DP).

Table 12. Summary of Affordability Ratios (AR).

AR Name	Abbr.	Equation	Affordability Threshold	Reference
Residential Indicator	RI =	$\frac{\text{Average wastewater \$/hhld}}{\text{MHI}}$	2%	(US EPA 1997)
Percentage of MHI	PI_{MHI} =	$\frac{\text{Average drinking water bill}}{\text{MHI of water system}}$	1.5% CA SWRCB 2.5% US EPA	(SWRCB 2016) (US EPA 2002)
Percentage of LQI	PI_{LQI} =	$\frac{\text{Average drinking water bill}}{\text{LQI of water system}}$	TBD	
Household Burden Indicator[1]	HBI=	$\frac{\text{Basic water service costs for 50 gallons per capita per day (gpcd)}}{\text{LQI of water system}}$	7% – 10%	(AWWA, NACWA, WEF Draft Report 2019)
Poverty Prevalence Indicator	PPI=	$\frac{\text{\# of households < 200\% FPL}}{\text{\# of households}}$	20% – 35% ≥ 35%	
Teodoro AR	AR_{20} =	$\frac{\text{Average water and sewer bill for 50 gpcd}^{2}}{\text{Discretionary income}^{3}}$	10% for customers at the 20th percentile income	(Teodoro 2018a)
Pacific Institute AR	AR_{PI} =	$\frac{\text{Average water and wastewater bill for 43 gpcd}}{\text{Discretionary income}^{4}}$	> 50% of customers spend 10% or more on drinking water	(Feinstein 2018)
AR at the Median Household Income	AR_{MHI} =	$\frac{\text{Average bill for 50 gpcd}^{5}}{\text{MHI of water system}}$	None provided	(Balazs et al. 2019)
AR at the County Poverty Threshold	AR_{CPT} =	$\frac{\text{Average bill for 50 gpcd}^{5}}{\text{County Poverty Threshold (CPT}^{6}\text{)}}$	None provided	(Balazs et al. 2019)
AR at the Deep Poverty Threshold	AR_{DP} =	$\frac{\text{Average bill for 50 gpcd}^{5}}{{}^{1}/_{2}\text{ times the CPT}^{6}}$	None provided	(Balazs et al. 2019)

[1] The numeric values shown for the HBI benchmark levels are preliminary, and subject to revision based on future empirical investigation; additional information is included in the above discussion of affordability metrics.
[2] Teodoro (2018) assumes 50 gpcd as a reasonable level of use to support health, sanitation, and basic household uses.
[3] Where discretionary income is after-tax household income minus essential costs including: shelter, health care, food, and home energy. The ratio is typically applied to the upper limit of the lowest income quintile but can also be applied at various income levels.
[4] Where discretionary income is household gross income minus expenses on shelter, health care, food, **transportation, telephone, laundry and cleaning**, home energy, and taxes. Items in bold were not included in the AR_{20}.
[5] Note that 50 gpcd for a household of 3 is 6 hundred cubic feet (HCF), which is used in the paper and converted here for consistency.
[6] CPT is a previously published value (Bohn et al. 2013, Public Policy Institute of California 2016).

Hours of Minimum Wage (HM). The hours of minimum wage worked per month to cover the cost of basic water and sewer service (Teodoro 2018a) provides an alternative way to view and communicate about the impacts of water and sewer costs on local households. As a guide, for a household of 4, no more than 8 hours of work at minimum wage should be needed to pay for affordable drinking and wastewater per month, so at a minimum wage of $11 per hour the total water and wastewater bills should not exceed $88 per month, which is 4.4% of the income for a full-time minimum wage worker.

Community and Water System Information – Participating Utilities

Data Sources

The following data were collected for use in the application (provided in the next sections) of the affordability metrics described above:

- Water system information from the State Water Resources Control Board (SWRCB) Division of Drinking Water (DDW) database (e.g., population served, service connections, water quality information), accessible here: https://sdwis.waterboards.ca.gov/PDWW/index.jsp
- Water system boundaries from the California Environmental Health Tracking Program (CEHTP 2018), accessible here: http://www.cehtp.org/page/water/water_system_map_viewer
- Water system details from water system representatives (e.g., water production, water rates, water user types and distribution)
- Socio-economic data from the U.S. Census Bureau, including median household income (MHI), 20th percentile household income, population, and community boundaries
    - From the 2017 1-Year U.S. Census ACS for the state of California (U.S. Census Bureau 2017a)
    - From the 2017 5-Year (2013 – 2017) U.S. Census ACS for the three participating utilities and for the state of California for direct comparisons (U.S. Census Bureau 2017b)[4]
    - Based on census designated place (CDP) for the two communities and based on the school district for the school
    - CDP boundaries can be accessed here: https://www.census.gov/geo/maps-data/data/cbf/cbf_place.html
    - U.S. Census ACS data can currently be accessed at https://factfinder.census.gov and will soon be accessible at https://data.census.gov
        - See DP03 for selected economic characteristics
        - See DP05 for demographic and housing estimates
        - See B25010 for average household size
- Cost of living data from the Bureau of Labor Statistics Consumer Expenditure Survey (BLS CEX 2018) as well as the Living Wage Calculator (Glasmeier 2018).

Proposed Nitrate Treatment and Associated Costs

Additional water system information and treatment options are detailed in the report titled *Proposition 50 Chapter 6b, Consolidated Management of Nitrate Treatment: Preliminary Assessment of Utilities and*

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[4] The 1-year U.S. Census ACS data are only available for locations with populations > 65,000 (https://www.census.gov/programs-surveys/acs/guidance/estimates.html), requiring the use of the 5-year ACS data for the small communities served by the utilities participating in the project. For California data, the 1-year ACS data were used except for comparison of community data with California data for which the 5-year ACS were used for California as well.

Treatment Cost Analysis (Corona Environmental Consulting & University of California, Davis 2018), developed previously by this research team. That report includes:

- An assessment of water quality and water production data for each of the participating water systems;
- Consideration of both non-treatment and treatment options to address contaminants;
- Proposed treatment and additional site improvements; and
- Capital equipment costs provided by treatment equipment vendors, estimated installed capital costs, and annual O&M costs.

Since the development of that report, estimated costs have been further refined, with consideration of distinct treatment scenarios with and without application of the consolidated management model. The treatment approach, assumptions, and costs for each of the water systems are summarized here; please refer to the previous report for additional information. Table 13 provides a summary of the contaminants and proposed treatment approach including Strong Base Anion Exchange (SBA-IX) for nitrate removal. Regarding RBG School, the basis of the current affordability assessment is SBA-IX treatment for the school; however, reverse osmosis treatment is currently being explored as an alternative option.

Table 13. Summary of proposed water system improvements for each of the participating systems.

RBG School	• Contaminants: Nitrate and 1,2,3-TCP
	• Primary Improvements
	  o SBA-IX for nitrate removal: Potable water only, 20 gpm design
	  o GAC for 1,2,3-TCP removal: Full flow treatment, 300 gpm design

LSID – Tonyville	• Contaminants: Nitrate, perchlorate, and arsenic • Primary Improvements o SBA-IX for nitrate, arsenic, and perchlorate removal
Woodville	• Contaminants: Nitrate, 1,2,3-TCP > MCL in recent years, current low-level • Primary Improvements o SBA-IX for nitrate removal

Treatment Cost Development

Budgetary cost estimates were requested from equipment suppliers, to be referred to as vendor A, B, C, D, and E.[5] The level of accuracy for the cost estimates corresponds to a Class 4 Estimate as defined by the Association for the Advancement of Cost Engineering (AACE) International. This level of engineering cost estimating is generally made with limited information, including process block diagrams, preliminary equipment lists, and indicated layout. Cost estimates prepared at this level of engineering are generally considered to have an accuracy range of +50/-30 percent. Installed capital costs include capital equipment costs with standard engineering multipliers to estimate installation, electrical and instrumentation & controls, building & general site civil, contingency, planning, engineering, legal, and admin. Specific costs for additional site improvements are not included (e.g., booster pump, new well pump, etc.). Such costs are inherent to the installed capital multiplier; however, costs associated with extensive site work may exceed the costs estimated with the installed capital multiplier. O&M costs for SBA-IX are driven primarily by salt consumption and brine waste generation and disposal; vendors provided estimated annual salt

[5] A1 refers to updated costs from vendor A for SBA-IX with standard regeneration; and A2 refers to updated costs from vendor A for SBA-IX with advanced regeneration.

consumption and annual brine waste volume, or the means to calculate them.[6] Additional assumptions are listed in Table 14.

Table 14. Assumptions for cost estimation.

Assumptions

- Arsenic (if > MCL) will be sufficiently removed by nitrate resin
- Non-hazardous waste brine
- Electricity @ $0.26/kWh
- Design basis using maximum nitrate
- Costs are subject to change and will be revised as costs are refined through the competitive bid process
- For calculations of household water cost, proportional O&M costs for industrial/commercial connections were excluded

O&M Costs		With Consolidated Management Approach	Without Consolidated Management Approach
Salt	$/lb	$0.09 (1)	$0.26 (4)
Disposal	$/gal	$0.30 (2)	$0.68 (5)
Labor	$/yr	$22,500 (3)	$40,000 (6)

1 Cost estimate provided by bulk salt provider in Fresno, CA; assumes 10-ton briner; includes delivery; multiple sites in 1 trip.
2 Waste disposal cost estimate provided by waste facility in the SJV, all inclusive.
3 Assumes weekly contract operator visits at $750/week with 2 sites in the same day; incudes $250/mon. per site for remote monitoring and data management.
4 Assumes purchase of 40-lb bags of salt, manually loaded; includes salt, delivery, and labor.
5 Based on brine disposal costs of an SBA-IX system operated in the region.
6 Assumes an operator with $100,000/year salary and benefits at 0.4 full-time equivalents (FTE); consistent with weekly contract operator site visits at $750/wk.

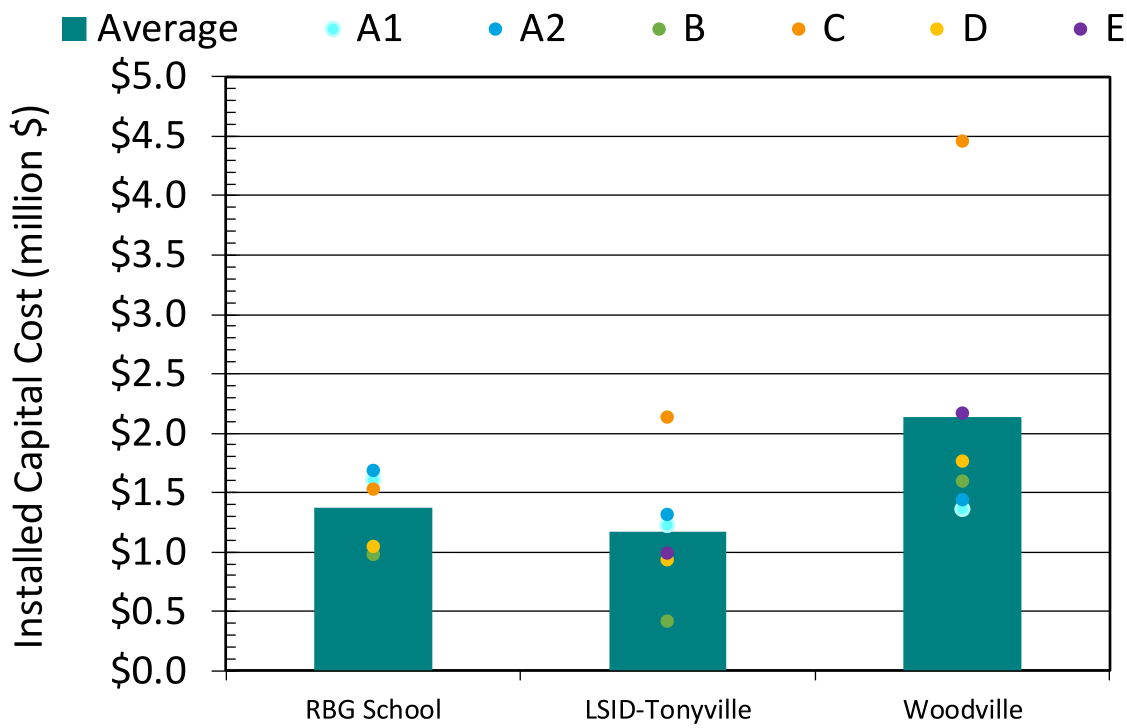
Summary of Treatment Costs

Installed capital costs for new treatment at each of the participating water systems are provided in Figure 5; the different colored points represent the installed capital cost corresponding to the different equipment suppliers (Vendors A-E). RBG School includes nitrate and 1,2,3-TCP removal; Tonyville includes nitrate, perchlorate, and arsenic removal; and Woodville includes just nitrate removal.

The range of capital costs reflects the variability in equipment and appurtenances that are offered by different manufacturers and different design philosophies. Often, simpler systems offer lower capital equipment costs in exchange for higher operational costs and require lifecycle analysis to determine the most effective solution for a given utility. Currently underway, the procurement of treatment equipment for the water systems participating in this Prop. 50 project includes a competitive bidding process where technical specifications are developed that will require the minimum equipment considered necessary for a fully functioning ion exchange system. This process allows for equipment selection based on a lifecycle cost analysis that takes into account capital costs and operational components including well utilization, maximum nitrate levels, salt use, and brine production.

[6] O&M costs include salt, disposal, media, labor, and pumping electricity and exclude GAC-specific labor, nitrate resin replacement, and other component replacement.

Figure 5. Installed capital costs for proposed treatment (vendor estimates, 2018 USD).



Annual O&M costs with and without consolidated management for new treatment at each of the participating water systems are provided in Figure 6. O&M costs include salt, disposal, media, labor, and pumping electricity and exclude GAC-specific labor, nitrate resin replacement, and other component replacement. Figure 7 illustrates O&M costs averaged across vendors, with costs broken down by type of O&M cost. O&M costs are substantially lower for RBG School, where nitrate treatment is for only the potable water, and highest for Woodville, the largest of the 3 systems. Based on current estimates, implementing consolidated management has the potential to reduce O&M treatment costs by as much as 55%. Figure 8 provides the annual total cost, including annualized capital (amortization 5%, 20 years). The Proposition 50 grant is funding capital costs for this project; annualized capital and total costs are included for consideration of the costs without grant funding.

Figure 6. Estimated annual O&M costs with and without consolidated management (CM) (vendor estimates, in 2018 USD).

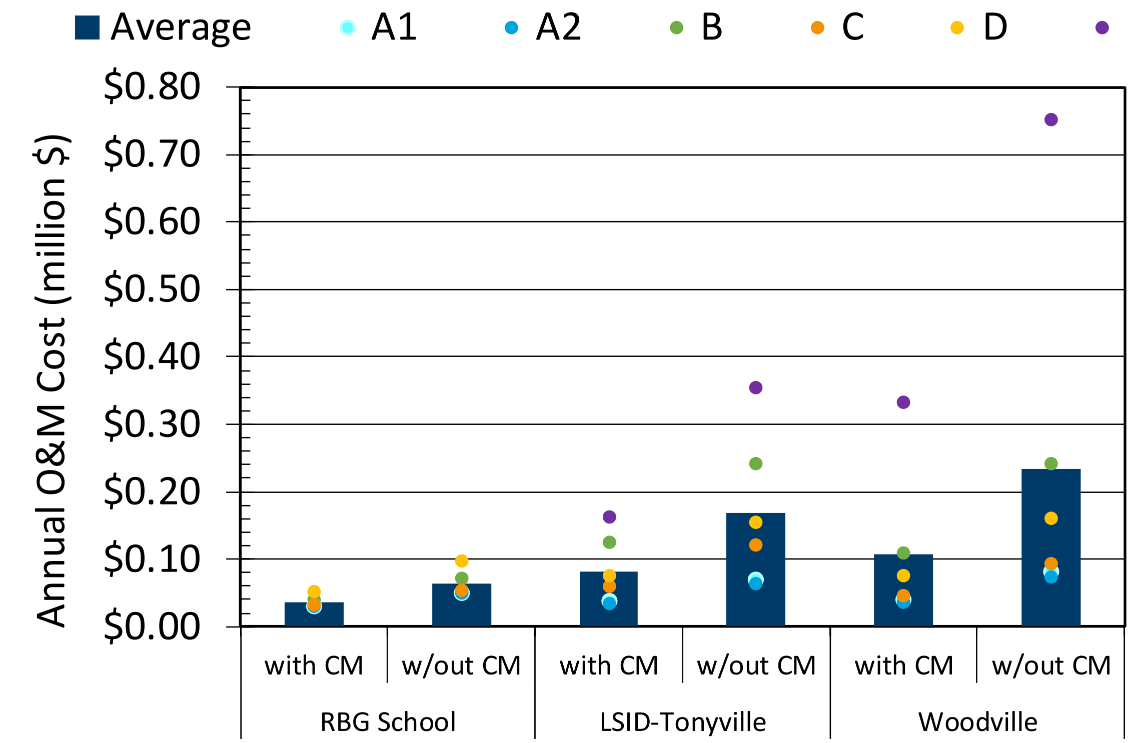


Figure 7. Estimated average annual O&M costs by category, with and without consolidated management (CM) (vendor estimates, in 2018 USD).

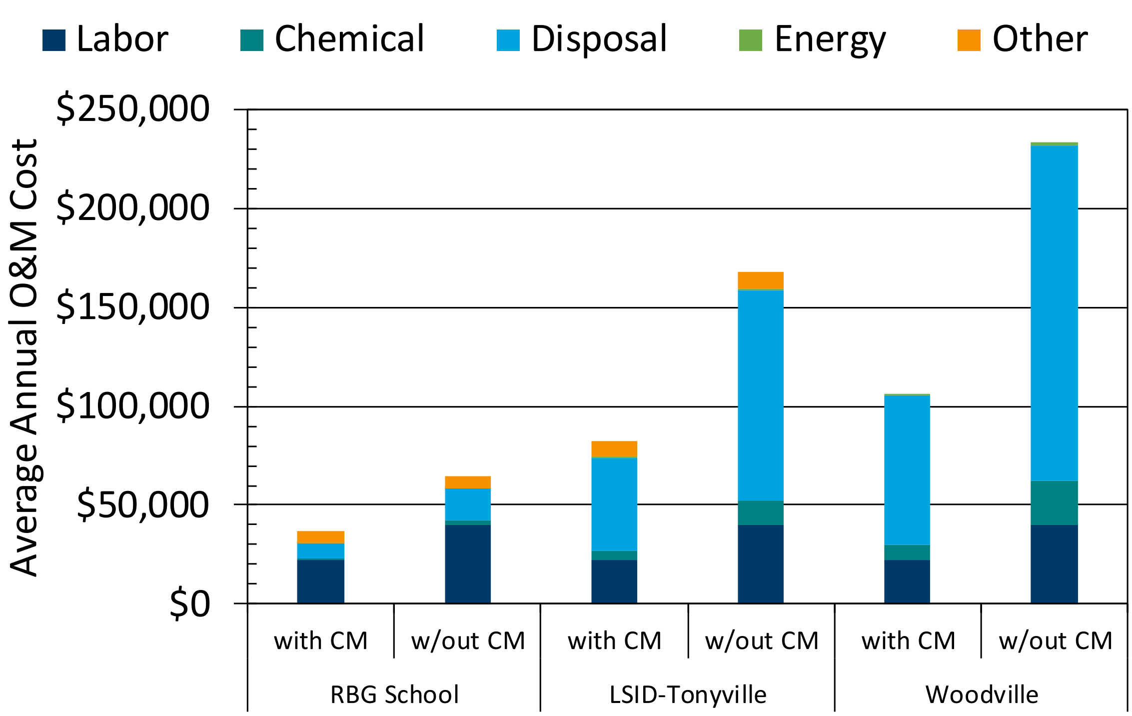
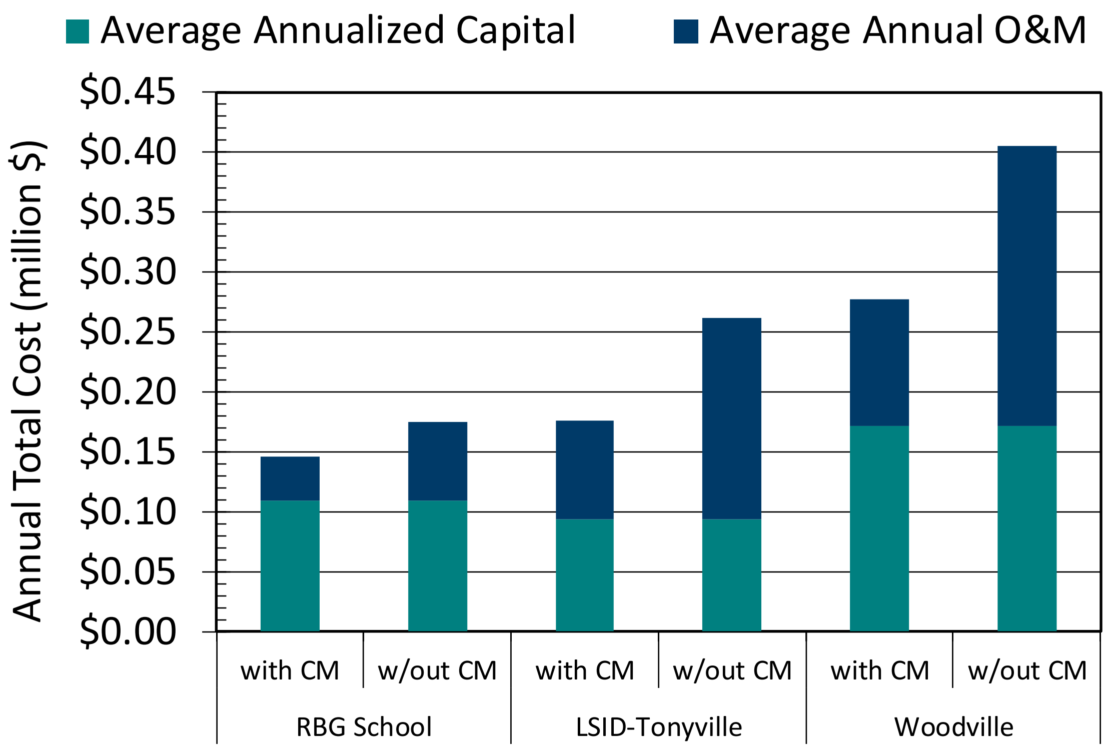


Figure 8. Annual total cost for proposed treatment including annualized capital and annual O&M (averaged across vendors), with and without consolidated management (CM) (2018 USD).



Affordability Assessment

Examination of the above estimated capital and O&M costs associated with treatment in the context of affordability metrics provides the means to assess affordability for the three participating water systems.[7] The affordability metrics detailed above have been used to assess the affordability of treatment for the participating utilities; the following metrics are included:

- Socioeconomic characteristics
- Non-discretionary spending requirements
- Household cost of water
- Affordability ratios.

Socioeconomic Characteristics of Participating Utilities

Socioeconomic characteristics of participating utilities are summarized in Table 15. While this report focuses on assessing the affordability of the three participating systems, affordability of treatment statewide will be further explored in future research during the next phase of the affordability assessment.

A higher cost of water, due to the need for treatment, can be particularly challenging for economically disadvantaged communities (DAC) and severely disadvantaged communities (SDAC). As mentioned previously, a DAC is defined as a community with an annual median household income that is less than

[7] As mentioned above, the costs used in the assessment of affordability are based on preliminary cost estimates and will be revised to include actual costs upon installation and operation of treatment at the participating utilities.

80% of the statewide annual median household income (MHI). An SDAC is defined as a community with an annual MHI less than 60% percent of the statewide annual MHI. The US Census Bureau ACS reported the CA MHI for 2017 was $71,805; a community MHI < $57,444 (80%) would classify as a DAC and a community MHI < $43,083 (60%) would classify as an SDAC (U.S. Census Bureau 2017a). LSID-Tonyville is classified as a DAC, with an MHI of $48,859 and Woodville is classified as an SDAC, with an MHI of $28,508 (U.S. Census Bureau 2017b). While the RBG School does not fall into these categories based on MHI, the Rio Bravo system is a school and is therefore considered disadvantaged due to the inability to raise rates to support the increase in costs associated with treatment.

The income characteristics for participating water systems, and statewide for California, are included in Table 15, including MHI, 20th percentile household income (LQI), and the percent of families and individuals with income below the FPL and below 200% of the FPL. The FPL is shown here rather than the SPM because the SPM is available only on a statewide or metro versus non-metro basis.

Table 15 lists California income characteristics based on 2017 5-year ACS data for California; for reference, the 2017 1-year ACS data have also been reviewed and have been referred to in previous sections of this report. According to the 2017 1-year ACS data, 9.6% of California families fall below the FPL and 25% of California families fall below 200% of the FPL, while 13.3% of CA individuals earn less than the FPL and 31% of CA individuals earn less than 200% of the FPL. The 5-year ACS data for CA (included in Table 15) are similar but averaged over 2013 – 2017; the 5-year data will be used subsequently for comparison with the community data for which 1-year data were not available. In comparison with state averages, both families and individuals in the RBG School district have lower poverty rates than the CA averages. Poverty rates are higher in the Tonyville, CA community, with 27.3% of families earning less than the FPL. Of the three communities, poverty rates are highest in the Woodville, CA community, with 45.4% of families earning less than the FPL.

Table 15. Summary of socioeconomic characteristics of participating utilities.[1]

		Rio Bravo	Tonyville	Woodville	CA
County		KERN	TULARE	TULARE	-
Population Served		887	500	1673	-
Connections		16	50	467	-
Households		N/A	100	446	-
Census Data					
Census Data Basis		School district	Tonyville CDP	Woodville CDP	State
Census CDP Population		4,451	684	1,770	38,982,847
# Housing Units		1,466	121	453	12,888,128
MHI		$94,048	$48,859	$28,508	$67,169
20th Percentile Household Income[2]		$34,702	$24,920	$15,191	$26,498
Unemployment Rate		9.8% +/- 5.6	10.4% +/- 12.0	12.7% +/- 5.0	7.7% +/- 0.1
% below FPL[3]	**– All Families**	5.4% +/- 4.3	27.3% +/- 32.4	45.4% +/- 9.8	11.1 +/- 0.1
	– All Individuals	10.8% +/- 6.6	35.4% +/- 29.8	49.7% +/- 9.9	15.1 +/- 0.1
% below 200% FPL[3]	**– All Families**	17.5% +/- 8.8	65.3% +/- 47.9	65.8% +/- 14.1	27.7% +/- 0.1
	– All Individuals	23.3% +/- 9.7	66.7% +/- 51.2	70.3% +/-13.9	33.9% +/- 0.2

[1] Data sources: ACS 2017 5 YR (2013 - 2017), DDW Database, and contact with water system representatives.
[2] Upper limit of lower quintile (LQI).
[3] Error values included following percent values as +/- percent value. Margin of error values were included in or calculated from US Census Data. Note the higher margin of error for the smaller datasets, particularly Tonyville.

In the consideration of MHI and other socioeconomic data for the participating communities, closer examination of service area and community boundaries was necessary. The service area of a water system does not necessarily coincide completely with the boundaries of a community and thus, the households included in US Census data by CDP may not necessarily correspond with the households served by the water system. For example, according to the DDW database, the LSID-Tonyville system serves a population of 500 people, while the population of the Tonyville, CA CDP, as reported by the US Census, is 684 people. To assess how well the US Census CDP data represent our water systems, the water system service area boundaries were compared with the CDP boundaries from the US Census (Figure 9 and Figure 10).

Figure 9. Woodville overlay of water system boundary and Census Designated Place boundary.

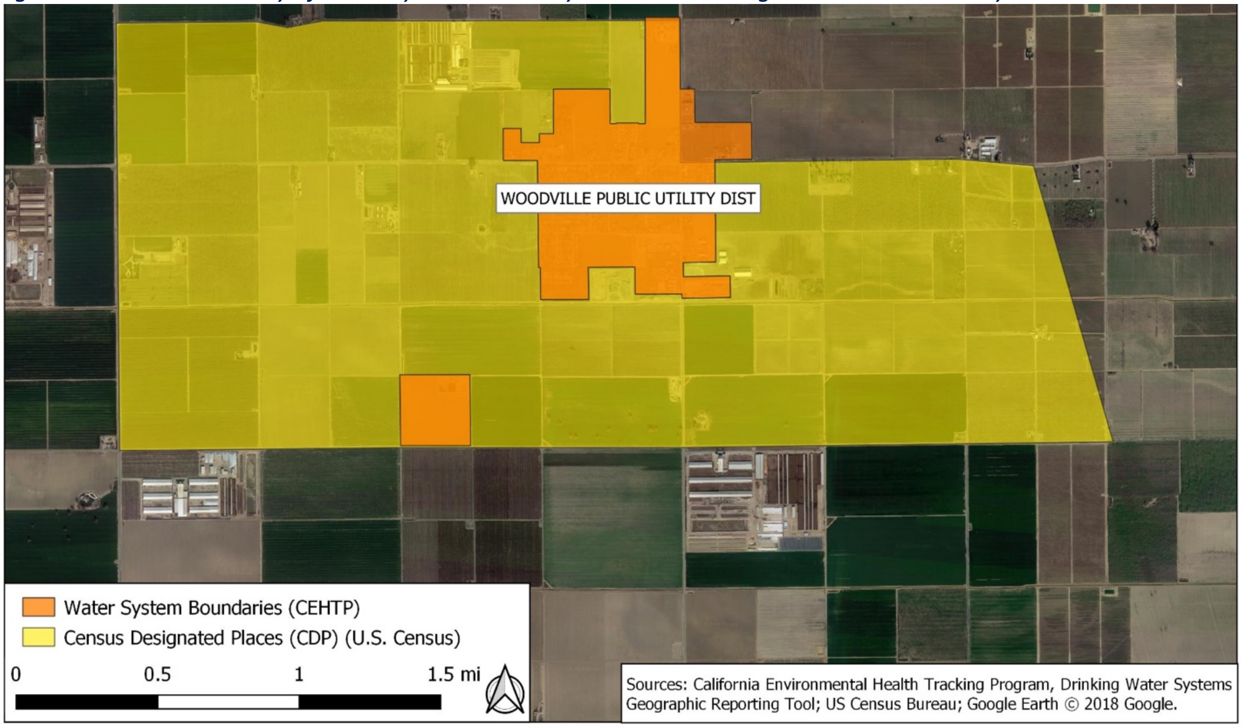


Figure 10. LSID-Tonyville overlay of water system boundary and Census Designated Place boundary.

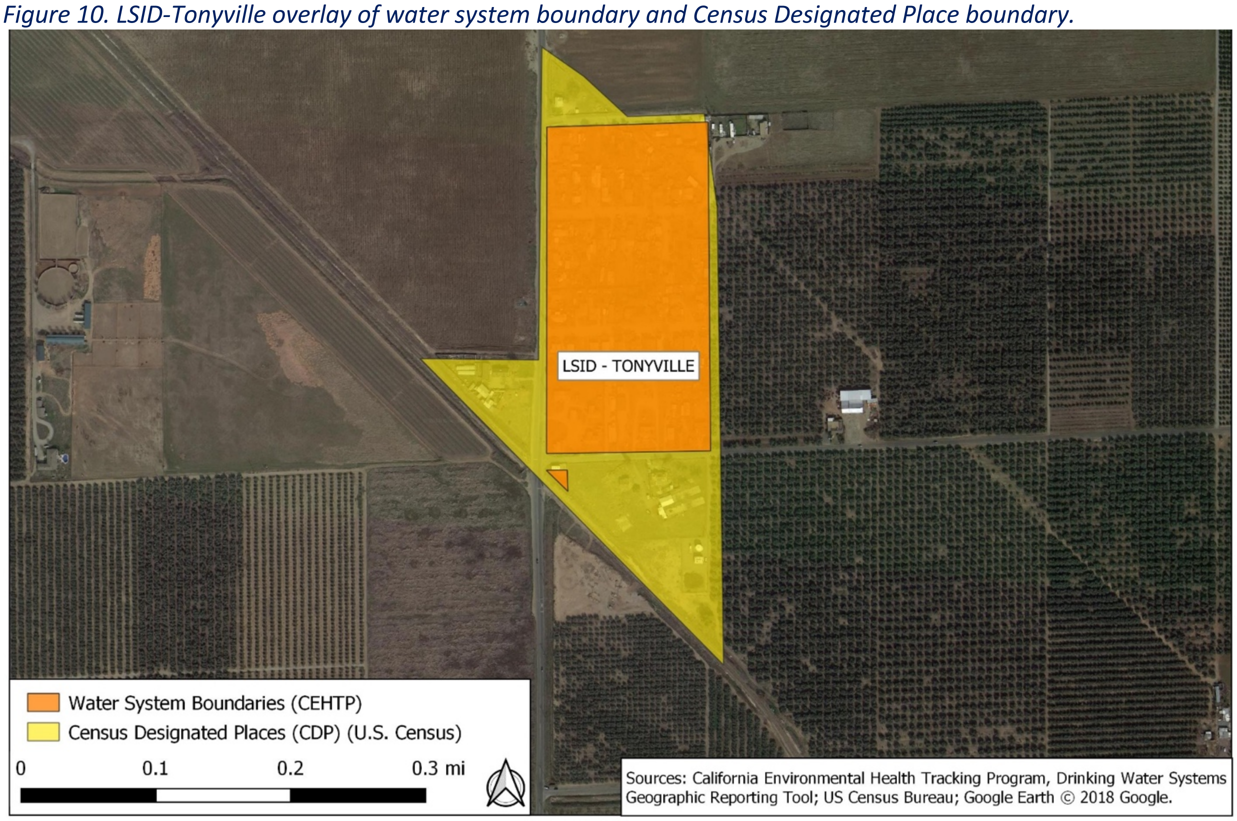
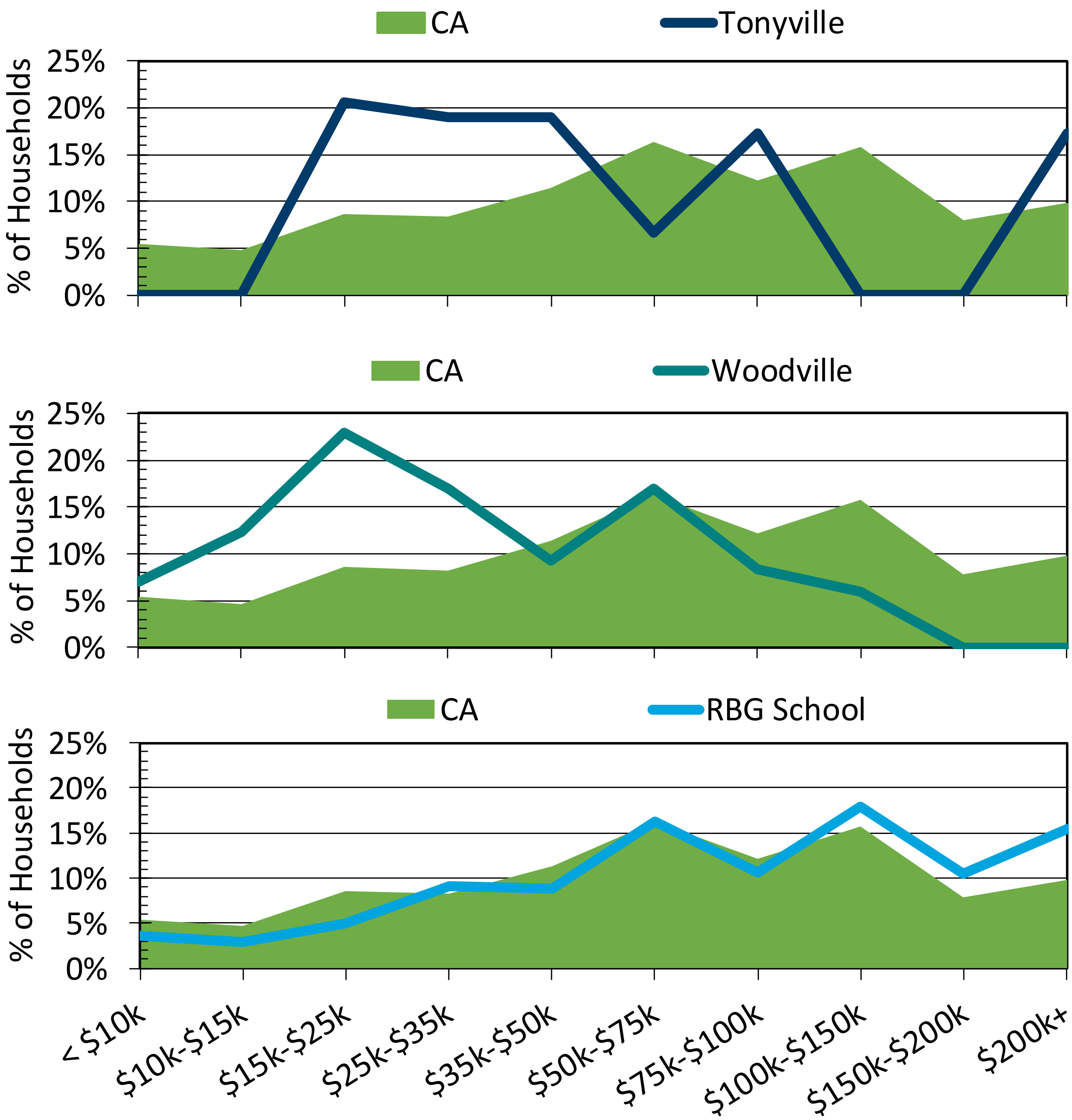


Figure 9 illustrates a large CDP area beyond the Woodville water system service area; however, the total population of the CDP is 1,770 while the population served by the water system is 1,673, indicating that the water system service area captures the vast majority of the CDP population. The socioeconomic dataset for the Woodville, CA CDP is thus assumed to be representative of the population served by the Woodville water system. Figure 10 depicts a close match of the Tonyville CDP area and the LSID-Tonyville water system service area, despite a higher CDP population (684 people, versus 500 people served by the water system). An LSID-Tonyville water system representative has indicated a high seasonal population, which may explain the closely matching boundaries and dissimilar reported population counts.

Figure 11 illustrates the income distribution of each of the communities relative to that of CA; there is a bimodal distribution of income in both the Tonyville and Woodville communities.

Figure 11. Income distribution of participating utilities compared with that of California (2017 U.S. Census ACS 5 Yr (2013 – 2017)).

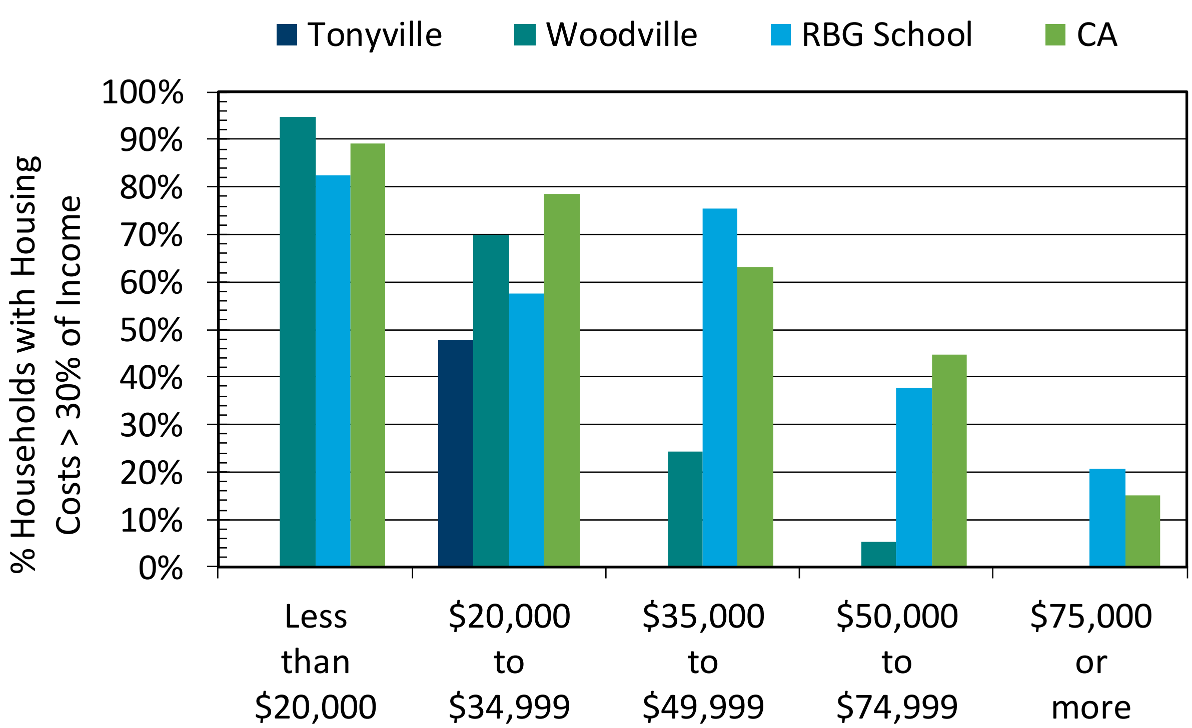


Non-Discretionary Expenditures

Comparison of local and state income to the FPL provides a starting point for assessing affordability but use of a broad federal threshold cannot account for regional and local economic factors related to the cost of living for basic essentials. To assess regional and local variations in the essential costs of living or non-discretionary expenditures, regional data have been examined.

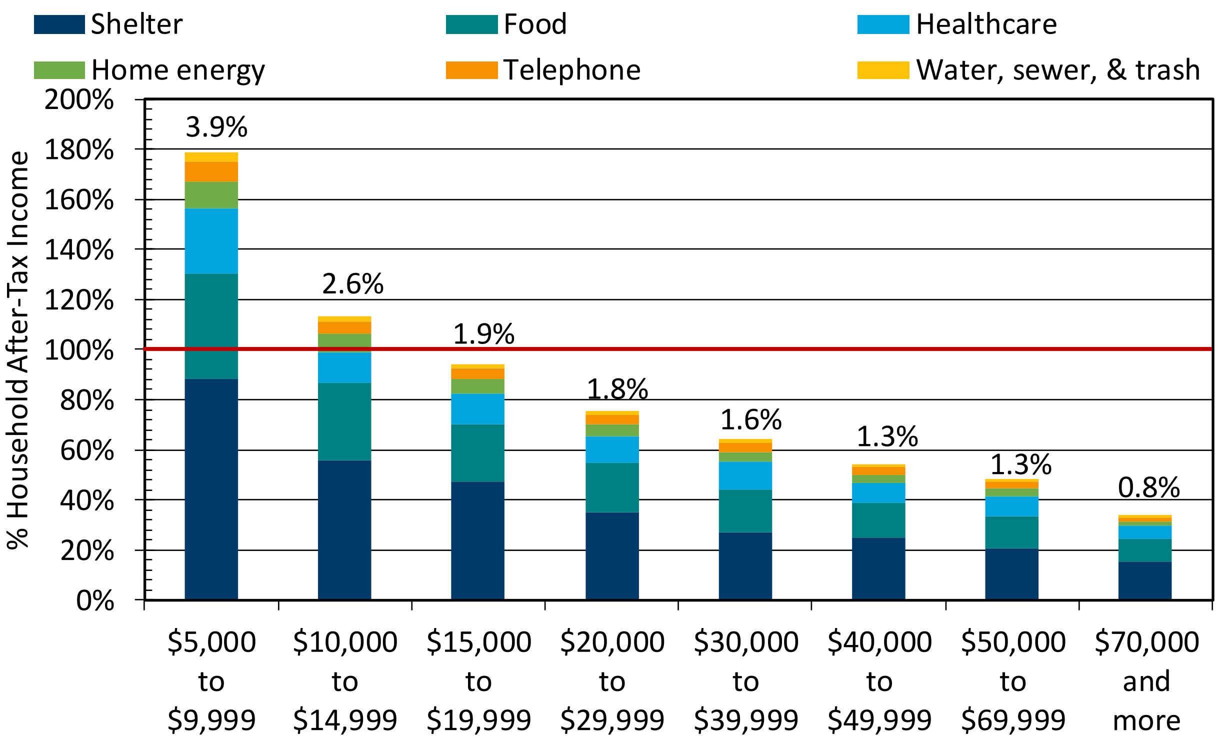
As discussed above, housing costs can be a significant burden with widely variable regional costs; shown in Figure 12, the three participating water systems have a high housing burden, meaning many households pay more than 30% of their income for housing. In Woodville, CA, U.S. Census data (2017 ACS 5-Year (2013 – 2017)) indicate that nearly 70% of households with annual income of $20,000 - $34,999 have housing costs more than 30% of household income and more than 90% of households with annual income less than $20,000 exceed the 30% threshold for affordable housing (U.S. Census Bureau 2017b). For reference, ~25% of Woodville households fall into the $20,000 - $34,999 income bracket and ~30% of Woodville households fall into the less than $20,000 income bracket. In 2015, 8 out of 10 low-income households in California, as defined by 200% of the FPL, were in unaffordable housing, meaning that they were spending more than 30% of household income on housing (Kimberlin 2017). In comparison, based on 2017 ACS 5-Year Census data, for households earning less than $50,000 per year, the percent of households paying more than 30% of income for housing was 69% in RBG School community, 32% in Tonyville, CA, 76% in Woodville, CA and 77% statewide.

Figure 12. Percent of households with housing costs greater than 30% of household income by income category (2017 U.S. Census ACS 5-Year (2013 – 2017)).



Based on the 2015 – 2016 Bureau of Labor Statistics Consumer Expenditure Survey (BLS CEX) data for the Western region of the U.S, Figure 13 shows average household expenditures for food, shelter, utilities, and healthcare by household income category (and the percentage that water, sewer, and trash account for). As shown, households in the lowest income categories are spending more than they earn on these basic items, on average. Moving up the income scale, non-discretionary expenses constitute a significant percentage of income for many households. For example, costs for food, shelter, utilities and healthcare account for 64% of incomes for households earning up to $39,999 per year. In California, expenditures likely constitute a higher percentage of income, on average, as the cost of living is much higher than the Western region average.

Figure 13. Select household expenditures as a percentage of household after-tax income, by income category, Western region of United States (Data source: BLS CEX, 2017). Note: Percentages listed at the top of each bar indicate the portion of household income accounted for by water, sewer, and trash on an annual basis.



The BLS CEX data include average results of actual expenditures reported by households within each income bracket. The corresponding average family size reported in the BLS CEX Western region data is 2.7 people.

The Living Wage Calculator, developed by Dr. Amy Glasmeier at the Massachusetts Institute of Technology, provides an alternative approach for consideration of non-discretionary expenditures accounting for both regional variation and different family compositions (Glasmeier 2018).

The Living Wage Calculator
Dr. Amy Glasmeier and the Massachusetts Institute of Technology (Glasmeier 2018)

"The living wage model is an alternative measure of basic needs. It is a market-based approach that draws upon geographically specific expenditure data related to a family's likely minimum food, childcare, health insurance, housing, transportation, and other basic necessities (e.g., clothing, personal care items, etc.) costs. The living wage draws on these cost elements and the rough effects of income and payroll taxes to determine the minimum employment earnings necessary to meet a family's basic needs while also maintaining self-sufficiency.

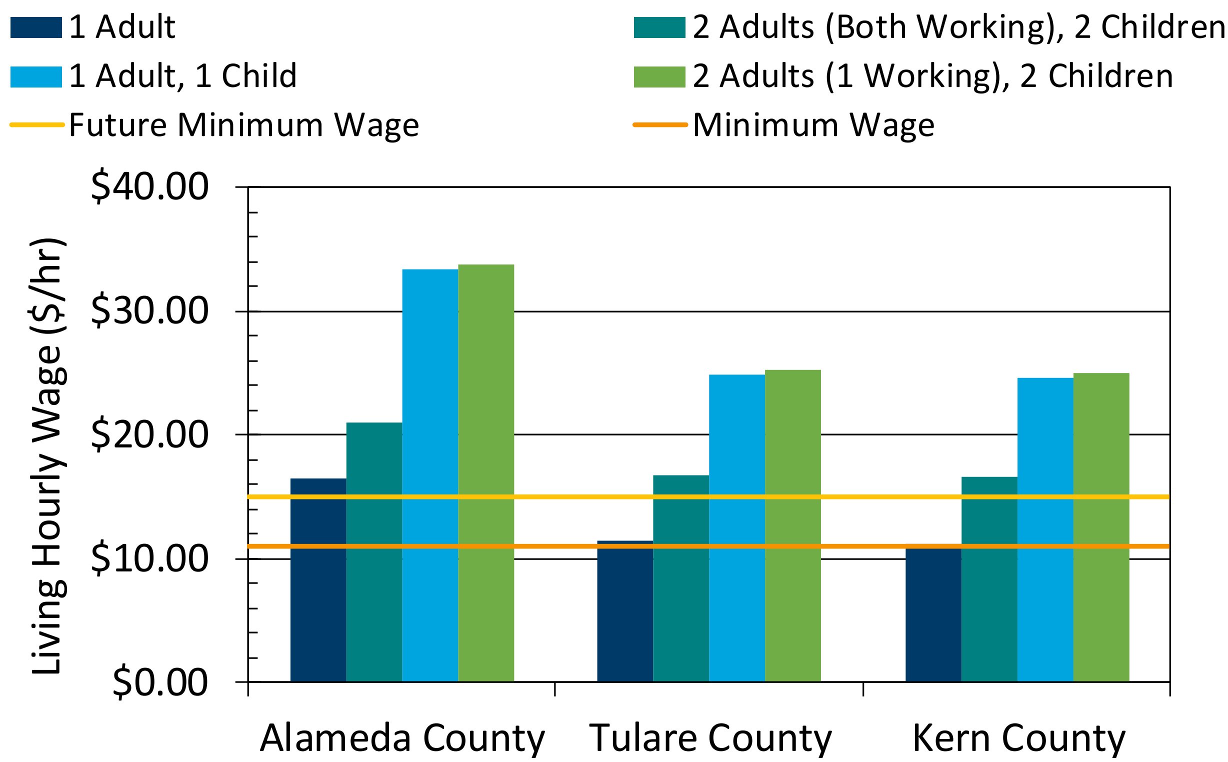
The living wage model is a 'step up' from poverty as measured by the poverty thresholds but it is a small 'step up', one that accounts for only the basic needs of a family. The living wage model does not allow for what many consider the basic necessities enjoyed by many Americans. It does not budget funds for pre-prepared meals or those eaten in restaurants. It does not include money for entertainment, nor does it allocate leisure time for unpaid vacations or holidays. Lastly, it does not provide a financial means for planning for the future through savings and investment or for the purchase of capital assets (e.g., provisions for retirement or home purchases). The living wage is the minimum income standard that, if met, draws a very fine line between the financial independence of the working poor and the need to seek out public assistance or suffer consistent and severe housing and food insecurity. In light of this fact, the living wage is perhaps better defined as a minimum subsistence wage for persons living in the United States."

The living hourly wages for three California counties are listed in Table 16 and illustrated in Figure 14, relative to the current minimum wage of $11/hr and the future minimum wage of $15/hr. The three participating utilities are located in Tulare County and Kern County; Alameda County, located in the San Francisco Bay Area, is included for reference. According to the results of the Living Wage Calculator, the living hourly wages for Tulare and Kern counties for a single adult are just above the current minimum wage in CA ($11/hour); however, the living wage in Alameda County and for families in all three counties is well above the current minimum wage.

Table 16. Living hourly wage by family size (http://livingwage.mit.edu/).

Family Size	Alameda County	Tulare County	Kern County
1 Adult	$16.48	$11.40	$11.14
1 Adult, 1 Child	$33.37	$24.83	$24.64
2 Adults (1 Working), 2 Children	$33.78	$25.23	$25.04
2 Adults (Both Working), 2 Children	$21.02	$16.74	$16.65

Figure 14. Living wage versus minimum wage (Data source: http://livingwage.mit.edu/).



Household Cost of Water

The household cost of water is an important component of an affordability assessment and is discussed below for the LSID-Tonyville and Woodville systems. The RBG School is not included because water service is provided to the school rather than a community; the increase in O&M costs for treatment will be borne by the school and thus, the concept of household water cost is not applicable.

Water rates were provided by the two communities participating in the project and are summarized in Table 17. For this assessment, it is anticipated that the increased operational costs due to treatment for nitrate and other contaminants will be reflected in a corresponding increase in water rates; however, capital costs are assumed here to be covered by state grant monies. Estimated future household water costs are also included in Table 17. Based on current estimates, the average monthly household water bill for LSID-Tonyville could increase from $12.19/month to $81/month (range of $41/month – $148/month across all vendors).[8] The average monthly household water bill for Woodville could increase from $26/month to $44/month (range of $32/month – $82/month across all vendors). Estimated future water bills were calculated as the current water bill plus the monthly increase per household needed to pay for the O&M costs for new treatment. For comparison, the average water bill in California reported by the

[8] For LSID-Tonyville, 2 households per connection were assumed; a system representative indicated that there is more than one household per connection in Tonyville. Based on a system population of 500 people and 50 connections, an assumption of 2 households per connection results in a family size of 5, which is close to the average household size of 5.65 reported in 2017 U.S. Census 5-Year ACS data (2013-2017). The average current monthly water bill reported for Tonyville was $24.38 per connection (Edwards 2018); assuming two households per connection, the corresponding average current monthly water bill per household is $12.19.

California Public Utilities Commission (CPUC) was $78/month in summer and $60/month in winter; however, the summary of rate information includes only a small subset of California utilities and mostly larger water systems (Rockzsffore & Zafar 2015).

Table 17. Current (2018) and estimated future water and sewer rates (with consolidated management and no capital costs borne for nitrate treatment).

	Tonyville	Woodville
Current water and sewer rates per household		
Average current water bill, $/month	**$12.19**[2]	**$25.75**
Water rate information (residential)	Fixed meter fee: $7.50/month Usage rate: $0.58/HCF	Flat rate: $17.25/month Usage rate: $0.50/HCF
Fixed water cost, $/month (per household)	$3.75	$17.25
Variable water cost, $/kgal	$0.78	$0.67
Average current sewer bill, $/month	**$26.92**[3]	**$19.75**
Wastewater rate information	Flat rate: $36.88/connection	Flat rate: $19.75
Average current sewer + water bill, $/month	**$39.11**	**$45.50**
Estimated future water rates per household[1]		
New treatment O&M bill increase, $/month	$68.68 ($29 – $135)	$17.92 ($6 – $56)
Average current water bill, $/month	$12.19	$25.75
Average future water bill, $/month	**$80.87 ($41 - $148)**	**$43.67 ($32 – $82)**
Average future sewer + water bill, $/month	**$107.80**	**$63.42**

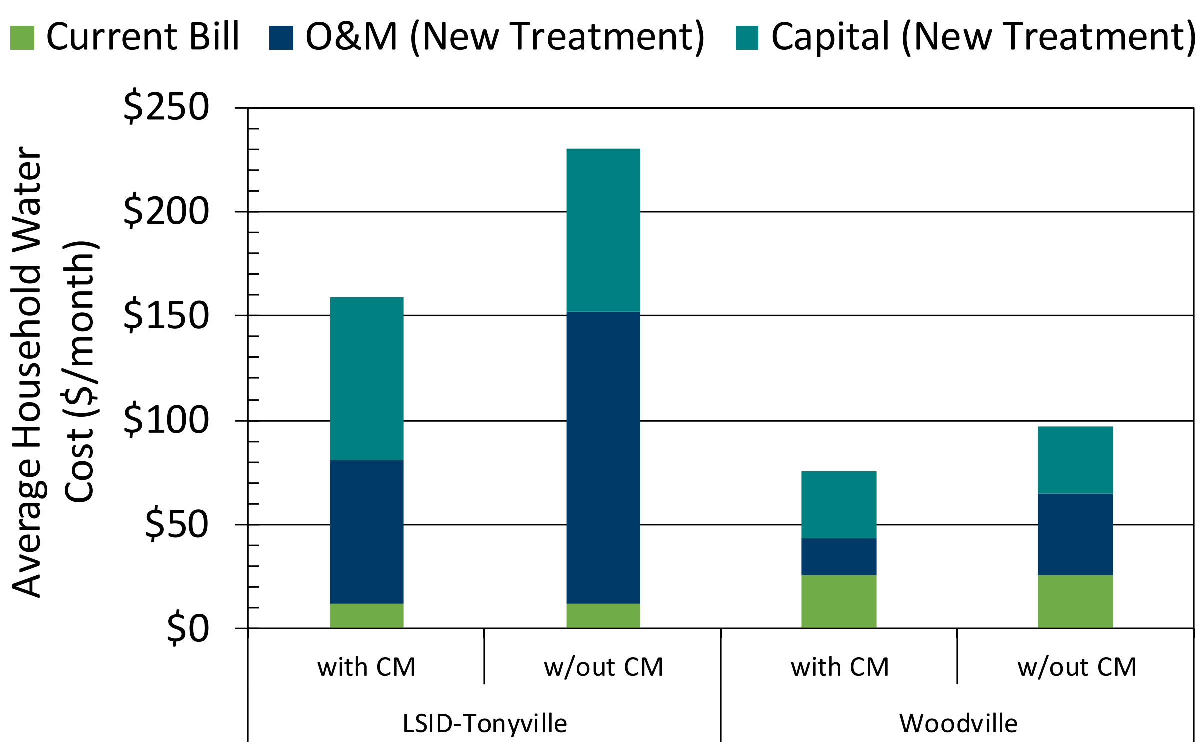
[1] Assumes consolidated management. Average across all vendors provided, with range in parentheses. Includes only the increase in the water bill associated with O&M costs. Capital costs associated with treatment are not included here as they are paid for by the Prop 50 grant.
[2] The average current monthly water bill reported for Tonyville was $24.38 per connection (Edwards 2018); assuming two households per connection as noted previously, the corresponding average current monthly water bill per household is $12.19. Similarly, the fixed water rate for Tonyville was reported as $7.50/month per connection resulting in a fixed water rate of $3.75/month per household.
[3] The average current monthly sewer bill reported by the City of Lindsay for Tonyville sewer service was $36.88/connections with 73 connections reported (City of Lindsay 2019). This cost was adjusted to be distributed over the assumed 100 households of Tonyville, resulting in an estimated 1.37 households per sewer connection and an average monthly sewer bill of $26.92/household.

Based on the estimated water service costs included in Table 17, household water cost as a percent of MHI and 20th percentile household income is provided in Table 18. The table lists the percent of household income spent on water, based on (1) the current average water bill, (2) the per household O&M costs for new treatment, (3) the current bill plus the per household O&M for new treatment (sum of 1 and 2), and (4) the current bill plus the per household O&M and capital costs for new treatment. As mentioned above, the Proposition 50 grant is funding capital costs for this project; capital costs are included in item (4) for consideration of the affordability of treatment costs without grant funding. The average monthly household drinking water costs, including current bill, new treatment O&M costs, and new treatment capital costs, are depicted with and without consolidated management in Figure 15.

Table 18. Cost of water as a % of household income based on current water bill and treatment costs with and without consolidated management (CM) (includes drinking water only) (2018 USD).

	Tonyville		Woodville	
MHI	$48,859		$28,508	
20th Percentile Income	$24,920		$15,191	
Avg Current Annual Water Bill (1)	$146		$309	
As a % of MHI	0.3%		1.1%	
As a % of 20th percentile income	0.6%		2.0%	
	With CM	**Without CM**	**With CM**	**Without CM**
New Treatment O&M Water Bill Annual Increase (2)	$824	$1,676	$215	$472
As a % of MHI	1.7%	3.4%	0.8%	1.7%
As a % of 20th percentile income	3.3%	6.7%	1.4%	3.1%
Avg Current Bill plus New Treatment O&M Increase (3)	$970	$1,823	$524	$781
As a % of MHI	2.0%	3.7%	1.8%	2.7%
As a % of 20th percentile income	3.9%	7.3%	3.4%	5.1%
Current plus New Treatment O&M and Capital (4)	$1,909	$2,762	$908	$1,164
As a % of MHI	3.9%	5.7%	3.2%	4.1%
As a % of 20th percentile income	7.7%	11.1%	6.0%	7.7%

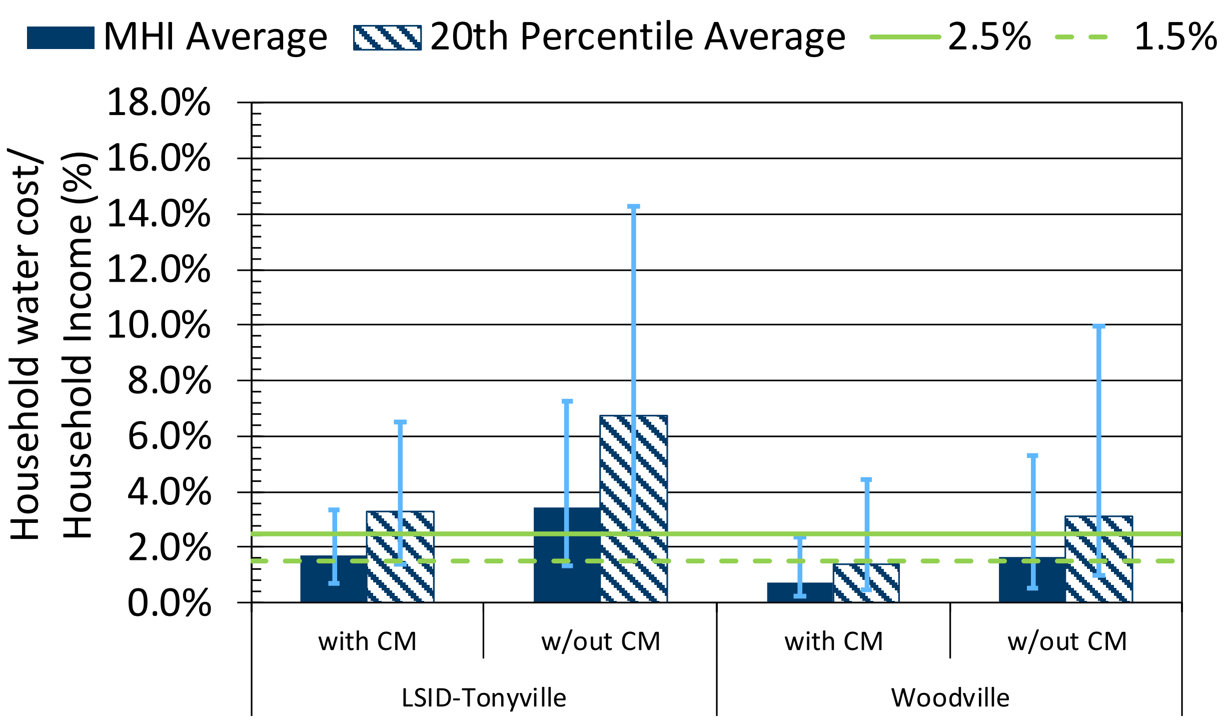
Figure 15. Average household water cost ($/month) including current bill, O&M costs for new treatment, and capital costs for new treatment.



The costs of water listed in Table 18 are compared in Figure 16 illustrating the cost of the new treatment O&M (item 2), Figure 17 illustrating the cost of the current water bill and new treatment O&M (item 3), and Figure 18 illustrating the cost of the current water bill and new treatment O&M and capital costs (item 4). In each of the three graphs, the percent of household income to cover the household cost of water is shown for the median household income and for the 20th percentile household income, with and without consolidated management (CM). Lines for a 2.5% threshold and a 1.5% threshold are included and are intended for use as a reference point with the MHI; the 2.5% and 1.5% thresholds do not apply for the 20th percentile household income. Error bars in each of the three graphs represent the maximum and minimum percent of income for the cost of water and correspond with the range of costs across treatment equipment suppliers.

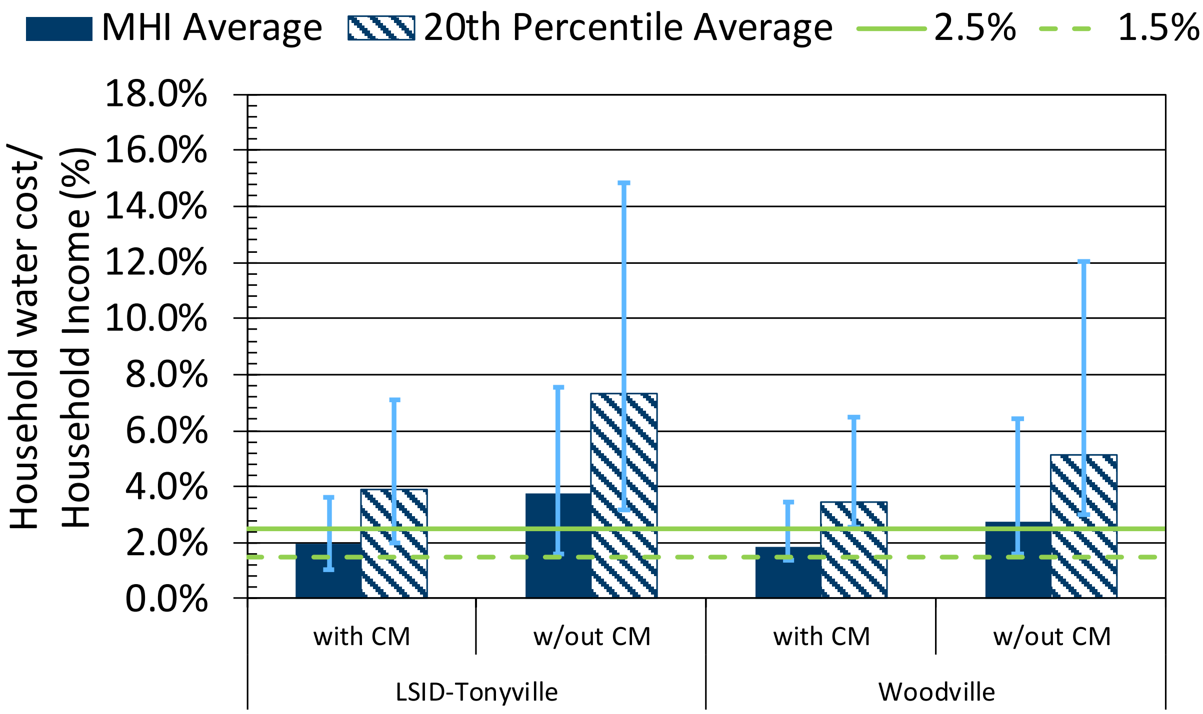
The percent of MHI that corresponds with just the O&M costs for new treatment (Figure 16) based on the average across vendors falls below the 2.5% threshold for both LSID-Tonyville and Woodville with CM, but only for the latter without CM. With the addition of the current water bill to estimate the average monthly water bill with treatment (Figure 17), the average percent of MHI across vendors lands above one or more thresholds for both systems, with and without CM. However, in the best-case scenario of current estimates, with maximum optimization, the lower O&M costs (lower error bar) with CM remain below the 2.5% and 1.5% thresholds for the MHI. With the inclusion of capital costs (Figure 18), the average percent of MHI is greater than both thresholds with and without CM for both systems; the minimum error bar for LSID-Tonyville, with and without CM, lands above the thresholds of affordability and the minimum error bar for Woodville lands just under the 2.5% threshold with and without CM. For households earning less than the MHI, affordability would be a greater challenge; with CM the average estimated water bill including O&M (excluding capital) for the 20th percentile household would be 3.9% and 3.4% of household income for LSID-Tonyville and Woodville, respectively. Inclusion of capital costs would increase that to 7.7% and 6.0% for LSID-Tonyville and Woodville, respectively.

Figure 16. Household water cost as a percent of household income for new treatment O&M only (excluding current bill and capital costs), with and without consolidated management (CM).



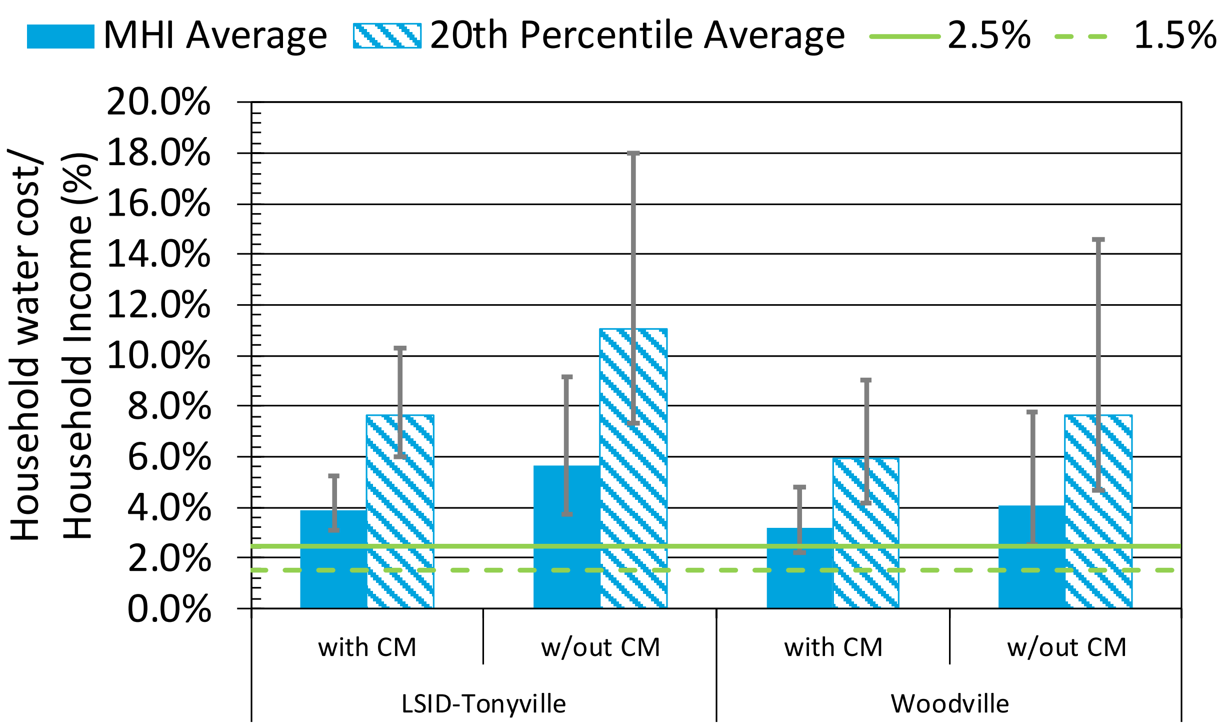
***Excludes current water bill, excludes capital costs for treatment.**

Figure 17. Household water cost as a percent of household income, including the current water bill and new treatment O&M (but excluding capital costs), with and without consolidated management (CM).



***Includes current water bill, excludes capital costs for treatment.**

Figure 18. Household water cost as a percent of household income, including the current water bill, new treatment O&M and capital costs, with and without consolidated management (CM).

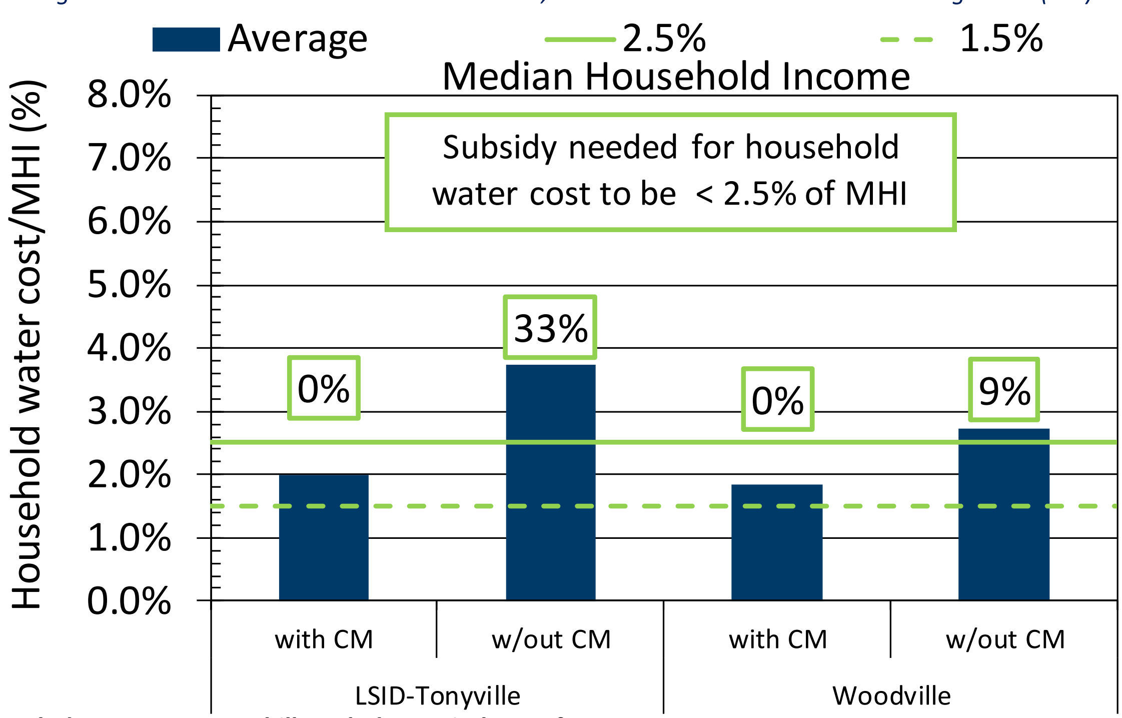


***Includes current water bill, includes capital costs for treatment.**

The subsidy required to bring the household cost of water below 2.5% of MHI is presented for each system with and without CM, including the average current water bill and the average O&M costs of new treatment, in Figure 19. The corresponding subsidy to bring the household cost of water below 1.5% of MHI is presented in Figure 20. The subsidy required to bring the household cost of water below 2.5% of MHI including the average current water bill, the average O&M costs of new treatment, and the average capital costs is provided in Figure 21.

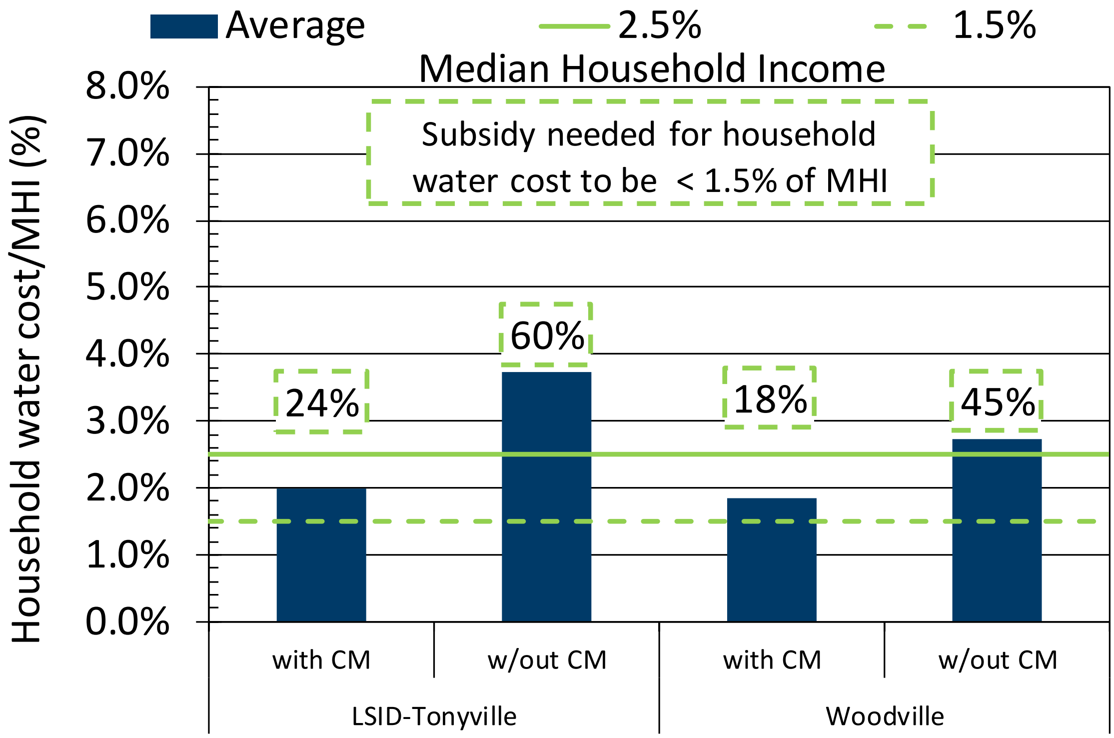
To bring costs below the 2.5% of MHI threshold (Figure 19) for LSID-Tonyville, excluding capital costs, no subsidy would be needed with CM, but a subsidy of 33% of the average monthly water bill would be needed without CM. For Woodville, excluding capital costs, no subsidy of the average monthly water bill with CM and a subsidy of 9% of the average monthly water bill without CM would be needed to bring costs below the 2.5% of MHI threshold. To bring costs below the 1.5% of MHI threshold (Figure 20) for LSID-Tonyville, excluding capital costs, a 24% subsidy of the average monthly water bill would be needed with CM, and a 60% subsidy of the average monthly water bill would be needed without CM. For Woodville, excluding capital costs, a 18% subsidy of the average monthly water bill with CM and a subsidy of 45% of the average monthly water bill without CM would be needed to bring costs below the 1.5% of MHI threshold. With the inclusion of capital costs (Figure 21), the average estimated monthly water bills would rise to levels requiring 21% – 56% subsidies to bring costs below the 2.5% of MHI threshold across both systems, with and without CM.

Figure 19. Required subsidy for household water cost to be less than 2.5% of median household income (MHI) including current water bill and new treatment O&M, with and without consolidated management (CM).



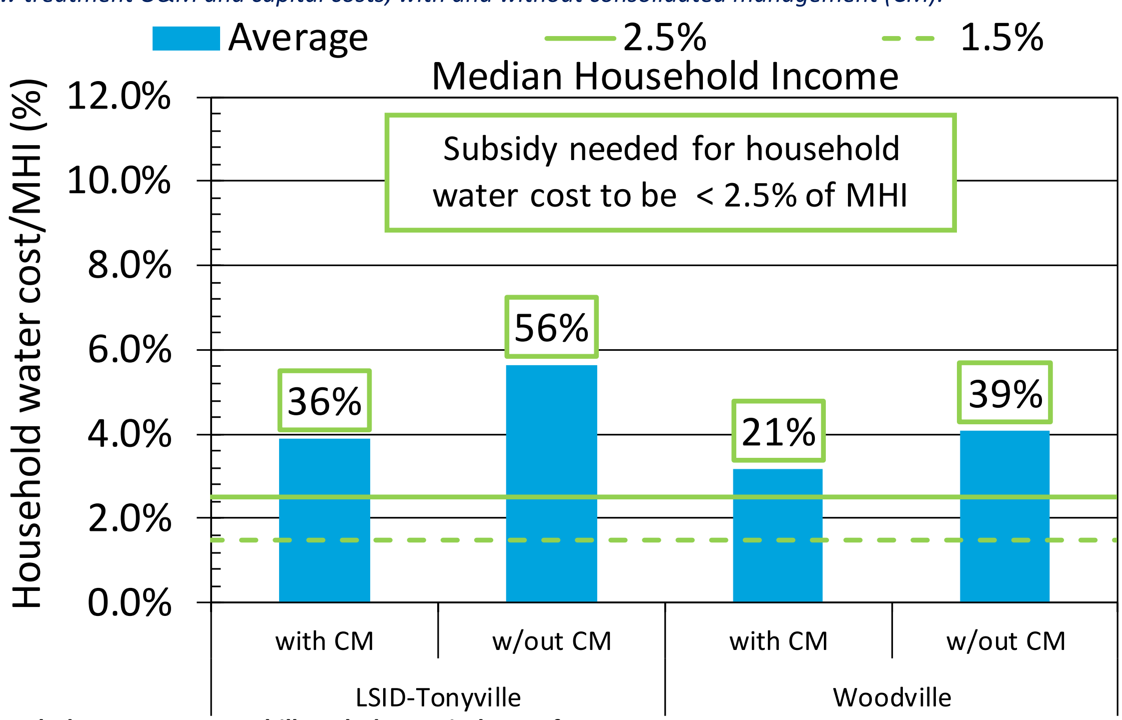
***Includes current water bill. Excludes capital costs for treatment.**

Figure 20. Required subsidy for household water cost to be less than 1.5% of median household income (MHI) including current water bill and new treatment O&M, with and without consolidated management (CM).



***Includes current water bill. Excludes capital costs for treatment.**

Figure 21. Required subsidy for household water cost to be less than 2.5% of MHI including current water bill and new treatment O&M and capital costs, with and without consolidated management (CM).



***Includes current water bill. Includes capital costs for treatment.**

Affordability Ratios

In addition to the use of socioeconomic characteristics such as MHI, 20th percentile household income, and poverty rates and the U.S. EPA and SWRCB metrics, multiple affordability ratios have emerged to improve upon previous metrics. The different affordability ratios discussed previously, AR_{20}, AR_{PI}, AR_{MHI}, AR_{CPT}, and AR_{DP} have been calculated for Tonyville and Woodville. These affordability ratios differ from previous metrics in two distinct ways: (1) they are generally based on the cost of water for basic use only (rather than average water costs for all water use) and (2) they are calculated as the cost of water as a percent of discretionary income rather than total income. As such, the threshold for what is affordable deviates from the 2.5% or 1.5% used above; the relevant affordability thresholds were discussed above (Table 12) and are included with the calculated ratios below for reference.

In the current analysis, essential expenditures are based on the 2016-2017 BLS CEX Western data by income level (September 2018). For more local results, housing costs can be substituted with HUD Fair Market Rents (FMR) by county, Census ACS median housing costs by CDP, or essential costs of living by county from the Living Wage Calculator (MIT); however, the inclusion or exclusion of utilities must be accounted for (BLS CEX Western data lists utilities separately). If it is assumed that utilities are all consistently included in the other data sources, the cost of water could be deducted based on (1) the current average water bill or (2) the water cost listed in the BLS CEX data. As an example, the housing costs for Woodville from different sources are listed in Table 19.

Table 19. Woodville, CA housing costs from different sources.

	Location Basis	Household Size	Income Basis	Housing $/month	Utilities
2017 5-Year US Census ACS	Woodville CDP	3.9	Median housing cost	$713	mixed
BLS CEX Western, 2016-2017	Western States	2.2	Average of MHI bracket	$823	separate
BLS CEX Western, 2016-2017	Western States	1.8	Average of LQI bracket	$745	separate
HUD Fair Market Rents (FMR) 2017	Tulare County	Efficiency	N/A	$663	included
HUD Fair Market Rents (FMR) 2017	Tulare County	1 BR	N/A	$668	included
HUD Fair Market Rents (FMR) 2017	Tulare County	2 BR	N/A	$873	included
HUD Fair Market Rents (FMR) 2017	Tulare County	3 BR	N/A	$1,265	included
HUD Fair Market Rents (FMR) 2017	Tulare County	4 BR	N/A	$1,452	included
MIT Living Wage Calculator	Tulare County	0 BR, 1 person	N/A	$623	included
MIT Living Wage Calculator	Tulare County	1 BR, 1-2 ppl	N/A	$650	included
MIT Living Wage Calculator	Tulare County	2 BR, 3-4 ppl	N/A	$844	included
MIT Living Wage Calculator	Tulare County	3 BR, 4-5 ppl	N/A	$1,222	included

The different affordability ratios calculated for Tonyville and Woodville are included in Table 20, with notes for each ratio to highlight differences between them. Based on Teodoro's AR_{20}, water and sewer costs are deemed unaffordable (i.e., >10% benchmark suggested by Teodoro 2018) with the inclusion of CM treatment for Tonyville and Woodville for 20th percentile households; in fact, based on this method, the 20th percentile income household in Woodville has insufficient income to pay for current estimated essential expenditures without water and sewer services. The PI_{MHI}, PI_{LQI}, HBI, and PPI are presented and compared in Table 21. Based on the percentage of income (PI) calculations and thresholds, the average estimated treatment costs are deemed unaffordable with and without consolidated management (CM) for both LSID-Tonyville and Woodville. Recall that the newly proposed HBI includes both drinking water and wastewater costs. The HBI has been calculated two ways: (1) based on the costs for basic water use (50 gpcd) and (2) based on the costs for average water use. Using the HBI and PPI, both LSID-Tonyville and Woodville exceed the PPI threshold having more than 35% of households below 200% of the FPL; however, only treatment costs without consolidated management for LSID-Tonyville (when combined with sewer costs) exceed the proposed affordability threshold and only on the basis of average water use.

Table 20. Calculated affordability ratios with comparison of current water costs versus current water costs plus the O&M costs for proposed new treatment, assuming consolidated management (CM).

	(1) AR_{T-20} (%)	(2) HM	(3) AR_{PI} (%)	(4) AR_{PI-20} (%)	(5) AR_{B-MHI} (%)	(6) AR_{CPT} (%)	(7) AR_{DP} (%)
Reference	Teodoro 2018	Teodoro 2018	Feinstein 2018	Feinstein 2018	Balazs et al. 2019	Balazs et al. 2019	Balazs et al. 2019
Threshold	10%	8 hr/month	10%	10%	None	None	None
Tonyville	**Average Household Size:**		**5**				
Income, $/year	$24,920	N/A	$26,900	$24,920	$48,859	$24,021	$12,011
Essential Expenditures, $/year	$18,437	N/A	$23,678	$24,050	N/A	N/A	N/A
Discretionary Income, $/year	$6,483	N/A	$3,222	$870	N/A	N/A	N/A
Household cost for basic water and sewer service:							
Current $/yr ($/mo)	$439 ($37)	$439 ($37)	$429 ($36)	$429 ($36)	$439 ($37)	$439 ($37)	$439 ($37)
With CM Treatment $/yr ($/mo)	$1,063 ($89)	$1,063 ($89)	$966 ($80)	966 ($80)	$1,063 ($89)	$1,063 ($89)	$1,063 ($89)
Metric – Current	**7%**	**3.32**	**13%**	**49%**	**0.90%**	**1.83%**	**3.65%**
Metric - With CM Treatment	**16%**	**8.06**	**30%**	**111%**	**2.18%**	**4.43%**	**8.85%**
Woodville	**Average Household Size:**		**3.8**				
Income, $/year	$15,191	N/A	$26,900	$15,191	$28,508	$24,021	$12,011
Essential Expenditures, $/year	$16,608	N/A	$20,329	$18,535	N/A	N/A	N/A
Discretionary Income, $/year	-$1,417	N/A	$6,571	-$3,344	N/A	N/A	N/A
Household cost for basic water and sewer service:							
Current $/yr ($/mo)	$490 ($41)	$490 ($41)	$483 ($40)	$483 ($40)	$490 ($41)	$490 ($41)	$490 ($41)
With CM Treatment $/yr ($/mo)	$562 ($47)	$562 ($47)	$546 ($45)	$546 ($45)	$562 ($47)	$562 ($47)	$562 ($47)
Metric – Current	**-35%**	**3.71**	**7%**	**-14%**	**1.72%**	**2.04%**	**4.08%**
Metric - With CM Treatment	**-40%**	**4.26**	**8%**	**-16%**	**1.97%**	**2.34%**	**4.68%**

(1) From Teodoro 2018, AR for LQI threshold provided. Income from US Census 2017 5-YR ACS 20th percentile household income for CDP. Essential expenditures (shelter, energy, food, taxes, healthcare) taken from BLS CEX Western States for corresponding income bracket. Basic water and sewer cost taken as 50 gpcd for the listed average household size.
(2) From Teodoro 2018, HM threshold provided. Basic water and sewer cost taken as 50 gpcd for the listed average household size. Based on minimum wage of $11/hr.
(3) Replication of results listed in Feinstein (2018), using very low-income limit for Tulare County from US HUD https://www.huduser.gov/portal/datasets/il/il2018/select_Geography.odn. Essential expenditures (transportation, home energy, food at home, laundry and cleaning, telephone, taxes, healthcare) taken from BLS CEX Western States for corresponding income bracket. Housing costs taken from HUD FMR 2018 for 2 BR unit (https://www.huduser.gov/). Basic water and sewer cost taken as 43 gpcd for the listed average household size.
(4) Same as (3) except income from US Census 2017 5-YR ACS 20th percentile income for CDP and housing cost from HUD FMR 2017 (to be consistent with BLS CEX year).
(5) The AR_{MHI} from Balazs et al. (2019), no threshold provided. Income from US Census 2017 5-YR ACS MHI for CDP. Basic water and sewer cost taken as 50 gpcd for the listed average household size.
(6) The AR_{CPT} from Balazs et al. (2019), no threshold provided. Income from PPIC (2014-2016) average CPM threshold including Tulare County (Bohn et al. 2013, Public Policy Institute of California 2016).
(7) The AR_{DP} from Balazs et al. (2019), no threshold provided. Income from PPIC (2014-2016), half of the average CPM threshold including Tulare County (Bohn et al. 2013, Public Policy Institute of California 2016).

Table 21. Comparison of calculated metrics and relevant thresholds, PI_{MHI}, PI_{LQI}, HBI, and PPI.

	LSID-Tonyville			**Woodville**		
	Serving 500 people, 100 households			Serving 1,673 people, 446 households		
	Current	**with CM**	**without CM**	**Current**	**with CM**	**without CM**
MHI	$48,859	$48,859	$48,859	$28,508	$28,508	$28,508
LQI	$24,920	$24,920	$24,920	$15,191	$15,191	$15,191
Annual Water Cost, DW only	$146	$970	$1,823	$309	$524	$781
Annual Water Cost, All	$469	$1,294	$2,146	$546	$761	$1,018
Annual Water Cost, All Basic	$439	$1,063	$1,709	$490	$562	$648
PI_{MHI}, 1.5% and 2.5%	0.3%	2.0%	3.7%	1.1%	1.8%	2.7%
PI_{LQI}, 3.5% and 5.5%	0.6%	3.9%	7.3%	2.0%	3.4%	5.1%
2.5% and 4%	0.6%	3.9%	7.3%	2.0%	3.4%	5.1%
HBI, 7%-10%, All	1.9%	5.2%	8.6%	3.6%	5.0%	6.7%
HBI, TBD[1], All Basic	1.8%	4.3%	6.9%	3.2%	3.7%	4.3%
PPI, 35%	65.3%	65.3%	65.3%	65.8%	65.8%	65.8%

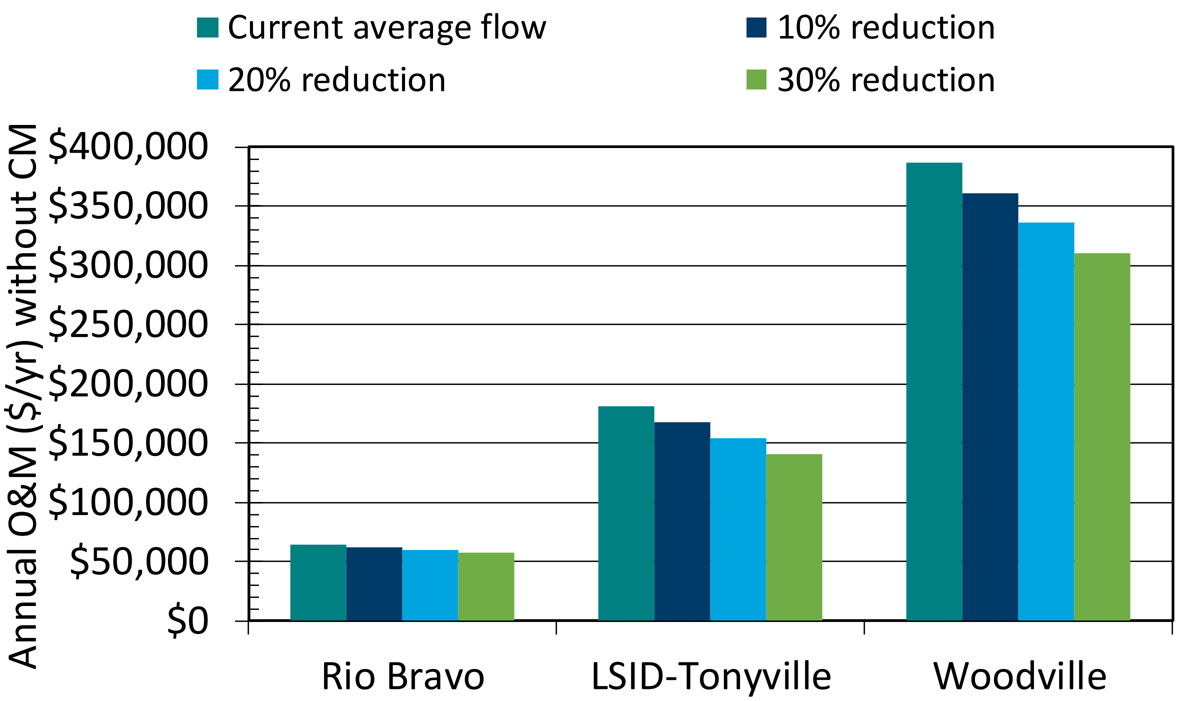
[1] Threshold range for HBI based on basic water only to be determined from further empirical data.

Additional Affordability Factors

Conservation

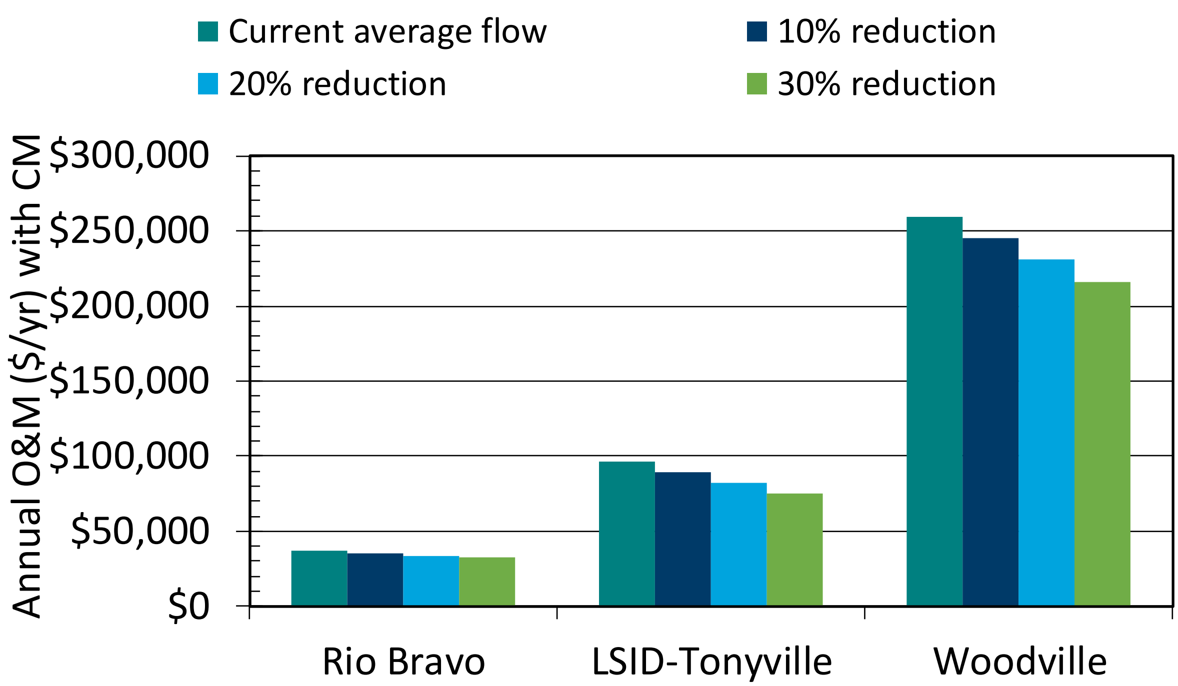
The cost of drinking water is largely linked to drinking water demand; reduction in water use has the potential to reduce costs and thereby improve affordability. Potential water conservation efforts can include installing high efficiency fixtures and appliances, repairing leaks, and avoiding wasted water (e.g., while brushing teeth, shaving, bathing). The cost impacts of water conservation measures to reduce water use by 10%, 20%, and 30% are depicted in Figure 22 and Figure 23 for treatment without and with consolidated management, respectively. These costs include current water costs for LSID-Tonyville and Woodville; however only the costs of treatment are included for RBG School. The calculation of reduced costs through conservation accounts for the flat water rate as well as the variable water rate reported by LSID-Tonyville and Woodville systems; RBG School does not have water rates and the below RBG School costs include only the cost of added treatment for indoor water use. While water conservation measures should be implemented and maintained to reduce overall costs, there is a limit to how much water use can be reduced. The above metrics have included consideration of the affordability of a limited amount of water to meet basic needs.

Figure 22. Cost reduction with conservation (10%, 20%, and 30% reduction in water use), without consolidated management (CM).



Rio Bravo costs include only treatment costs and only indoor water use.

Figure 23. Cost reduction with conservation (10%, 20%, and 30% reduction in water use), with consolidated management (CM).



Rio Bravo costs include only treatment costs and only indoor water use.

Bottled Water Costs

The relative cost of purchasing bottled water for drinking and cooking water has also been examined. Water use for drinking and cooking has been estimated at 1 gpcd based on information from the Federal Emergency Management Agency (FEMA) (Federal Emergency Management Agency 2004). The National Academy of Sciences (NAS) has estimated 0.7 gpcd of potable water (National Academy of Sciences 2004); use of the FEMA estimate should be conservative. The cost of bottled water delivery (5-gallon bottles) from Alhambra is approximately $1.68/gallon (Alhambra Representative 2019). Alternatively, the cost of self-serve water refill is approximately $0.35/gallon (Primo Water 2019); however, this does not account for the time and inconvenience of going to the refill station and transporting the water to the home. Drinking and cooking water use and associated costs were calculated for LSID-Tonyville and Woodville and are summarized in Table 22. RBG School has been using bottled water since August 2015 due to nitrate and then 1,2,3-TCP contamination of their drinking water supply. The RBG School provided the associated costs and estimated volume of drinking water use, also included below.

Based on the above assumptions, estimated costs for bottled water use for drinking and cooking range from $53 - $255/month per household in the Tonyville, CA community; $40 - $192/month per household in the Woodville, CA community; and $3,632/month for the RBG School.

Table 22. Estimated costs for using bottled water for drinking and cooking.

	LSID-Tonyville	LSID-Tonyville	Woodville	Woodville	RBG School
Households	100	100	446	446	N/A
Population	500	500	1673	1673	887
Bottled Water Use, gal					
Systemwide, per day	500	500	1673	1673	410
Systemwide, per month	15,208	15,208	50,887	50,887	6,150
Systemwide, per year	182,500	182,500	610,645	610,645	73,800
Household, per day	5.0	5.0	3.8	3.8	N/A
Household, per month	152	152	114	114	N/A
Household, per year	1,825	1,825	1,369	1,369	N/A
Bottled Water Cost					
Bottled water, $/gal	$1.68	$0.35	$1.68	$0.35	$0.54
Annual cost, System	**$306,478**	**$63,875**	**$1,025,477**	**$213,726**	**$39,957**
Annual cost, Hhld	**$3,065**	**$639**	**$2,299**	**$479**	**N/A**
Monthly cost, Hhld	**$255**	**$53**	**$192**	**$40**	**N/A**

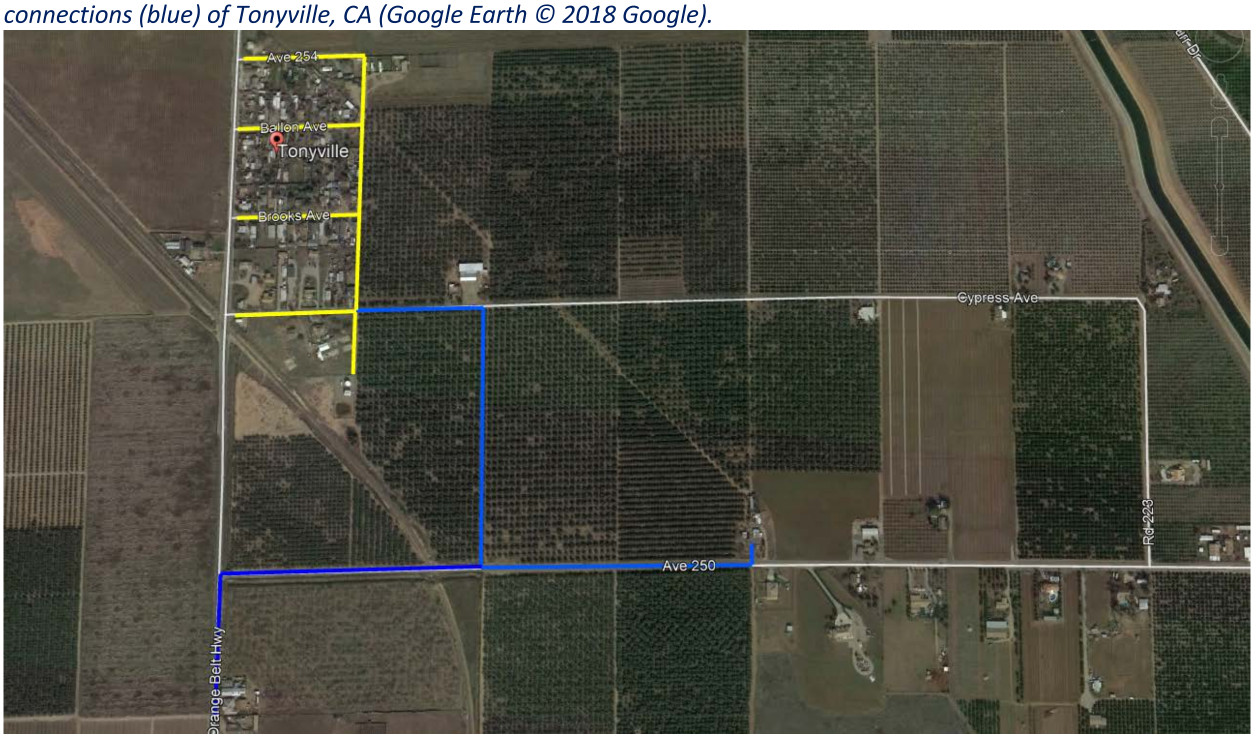
Separate Piping for Indoor Water

Another alternative for consideration is treatment of only indoor water and installation of a separate pipeline in the distribution system for delivery of only treated water for indoor uses. By separating irrigation water, only indoor water would require treatment. This would result in (1) smaller sized treatment equipment, thereby decreasing associated capital costs and (2) treatment of less water, thereby decreasing associated O&M costs. However, the tradeoff would be the increased capital expenditure for installation of new piping.

Using the LSID-Tonyville system as an example; new potable only piping for the system's primary connections would total ~4,150 ft (Figure 24) and addition of the system's peripheral connections would total ~9,550 ft of new pipeline (Figure 25). The estimated new pipeline length is only a rough approximation and does not include additional piping from the street to each individual home.

Figure 24. New pipeline for only potable water distribution to primary connections of Tonyville, CA (Google Earth © 2018 Google).

Figure 25. New pipeline for only potable water distribution to primary connections (yellow) and peripheral connections (blue) of Tonyville, CA (Google Earth © 2018 Google).



Treatment assumptions are as described above in the section titled Treatment Cost Development. Additional assumptions include $200/linear foot for the new pipeline; $50,000 for backflow prevention devices for all connections ($1,000 per device, 50 connections); that the existing tank is used for potable water storage; and estimation of indoor water based on winter demand.

The associated costs are presented in Table 23 comparing (1) treatment of all water with no separation of indoor water and no new pipeline and (2) separation of irrigation and indoor water with new potable only pipeline and treatment of only indoor water. For reference, an additional scenario with new pipeline to only primary connections is also included. Based on the listed assumptions, the capital savings of having a smaller treatment system to treat only indoor water are low compared to the higher relative capital cost for new piping for treated indoor water only. The O&M savings over time do not make up for the high cost of new piping; however, if the intent is to spend more upfront to minimize ongoing O&M costs, then another consideration may be new piping with treatment of only potable water (drinking and cooking), to maximize ongoing O&M savings.

Table 23. LSID-Tonyville example of cost tradeoff for new potable only pipeline with treatment of only indoor water versus treatment of all water and no new piping.

	Treatment of All Water, Existing Piping	Treatment of Indoor Water Only, New Piping	Treatment of Indoor Water Only, New Piping, Primary Connections
Treatment Costs			
Installed Capital Treatment Cost	$1.120M	$0.832M	$0.832M
Estimated Annual O&M[1]	$0.082M	$0.061M	$0.061M
Annual O&M Savings	$0	$0.022M	$0.022M
Savings over 20 years	$0	$0.436M	$0.436M
Estimated Household Bill ($/mon), O&M only	$69	$51	$51
Piping Costs			
Distance to primary connections, ft	N/A	4,150	4,150
Distance to peripheral connections, ft	N/A	5,422	N/A
Total distance, ft	N/A	9,575	4,150
Unit cost, $/linear foot	N/A	$200	$200
Piping to primary connections, $	N/A	$0.830M	$0.830M
Peripheral connections, $	N/A	$1.080M	N/A
Backflow prevention, $	N/A	$0.050M	$0.045M
Total, $	N/A	$1.960M	$0.875M
Total Costs			
Treatment Installed Capital	$1.120M	$0.832M	$0.832M
Piping Installed Capital	N/A	$1.960M	$0.875M
Total Installed Capital	$1.120M	$2.792M	$1.707M
Added Capital Cost for New Pipeline	**N/A**	**$1.672M**	**$0.587M**
20-Year O&M	$1.648M	$1.213M	$1.213M
O&M Savings for New Pipeline Scenario	**N/A**	**$0.436M**	**$0.436M**

[1] Assumes consolidated management.

Affordability Assessment – Future Research

Potential future objectives of the affordability assessment include:

- Revisions to include actual costs upon installation and operation of treatment at the participating utilities;
- Completion of Part 3 of the Affordability Assessment, focusing on policy options and potential funding mechanisms to address affordability challenges for economically disadvantaged communities; and
- Further development of recommendations for addressing affordability on a statewide basis.

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