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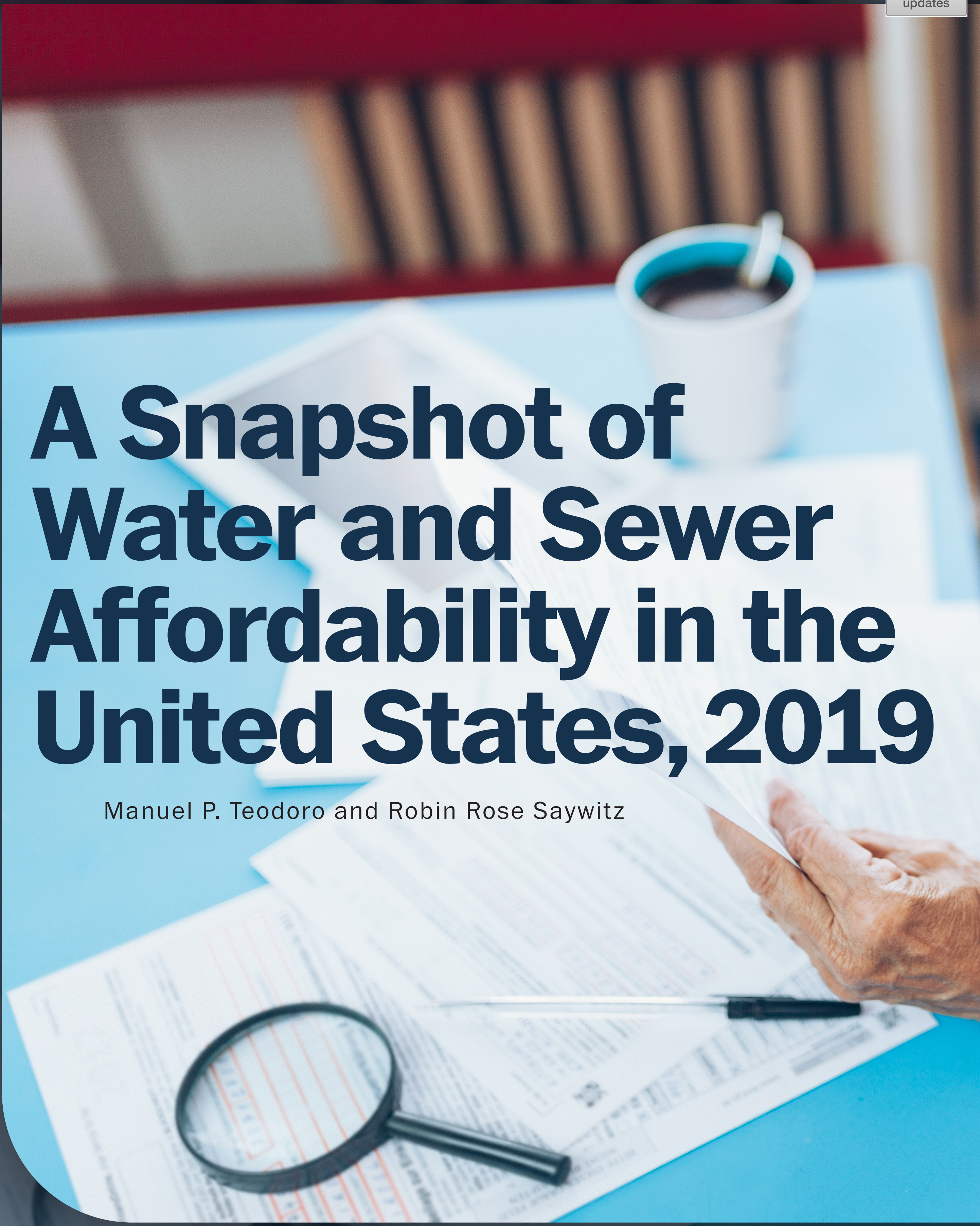
A Snapshot of Water and Sewer Affordability in the United States, 2019

Manuel P. Teodoro and Robin Rose Saywitz



Key Takeaways

In 2019, US utilities on average charged the equivalent of 10.1 hours' labor at minimum wage for basic monthly water and sewer service for a four-person household.

Basic water and sewer service cost an average of 12.4% of disposable income for a four-person household at the 20th percentile income.

US water and sewer service on average became less affordable over the past two years, varying by region and utility ownership, driven by increasing water and nonwater prices.

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This article provides a snapshot of water and sewer affordability in the United States using data from a nationally representative sample of water and sewer utilities in 2019. As is the case in many industrialized countries, affordability is a mounting concern for the American water sector, as long-deferred infrastructure replacement needs and upgrades have driven utilities to raise prices. Combined with rising costs of living and uneven wage growth, increased prices for water and sewer services can create significant economic difficulties for low-income customers. An accurate, meaningful picture of affordability conditions is important as governments, utilities, and communities grapple with this mounting challenge.

Following the same measurement and sampling methodology employed in Teodoro's (2019) original national analysis of affordability, this article focuses on *basic* water demands and *low-income* affordability. Specifically, we evaluate affordability with the metrics advanced by Teodoro (2018): the affordability ratio (Table 1) at the 20th percentile income (AR_{20}) and a transformation of monthly water and sewer bills into hours of labor at minimum wage (*HM*). Comparisons of affordability in 2017 and 2019 provide a useful picture of current conditions and short-term national trends in affordability. This article summarizes our key findings; the methodological and analytical details of this study are reported in a companion *AWWA Water Science* article (Teodoro & Saywitz 2020).

Our main finding is that in 2019, low-income households had to spend an average of 12.4% of their disposable income and/or work 10.1 hours at minimum wage to pay for basic monthly water and sewer service—up from 10.9% and 9.9 hours in 2017. Analysis of change over the two-year period shows that differences in rate structures and economic conditions combined to put greater pressure on affordability across much of the United States.

Assessing the affordability ratio at the 20th percentile income rather than at median income focuses analysis on low-income households.

Assessing Affordability

Like the affordability of anything, water and sewer affordability is a function of utility prices relative to the prices of other things as well as the resources that customers have available. Our focus is on the affordability of basic water and sewer service—for drinking, cooking, cleaning, and sanitation—for low-income households. We are interested in household affordability rather than system-level financial capability, which refers to a community's overall capacity to pay for its capital and operating needs (Davis & Teodoro 2014).

Popular interest in water and sewer affordability in the United States continues to grow, but rigorous, systematic research on the subject remains rare. Past empirical assessments of water affordability generally rely on a flawed measurement convention: average water and sewer bill as a percentage of median household income (%MHI), with a combined value less than 4.0 or 4.5 designated as "affordable." However, the %MHI convention is an inappropriate method of measuring household-level affordability for at least four reasons. First, average residential demand inflates the cost of water and sewer service because average

Descriptive Summary of 2019 Mean Affordability Ratio at 20th Percentile Income and Hours of Labor at Minimum Wage

Variable	Mean	95% Mean CI	Minimum	Maximum
Hours of labor at minimum wage	10.1	[9.5, 10.7]	1.6	27.0
20th percentile income	12.4	[10.9, 13.9]	1.4	100

n = 399. Poststratification weights applied in parameter calculations.

CI—confidence interval

Table 1

residential water consumption is much higher than basic needs would dictate (DeOreo et al. 2016). Second, the %MHI convention's focus on *median* income neglects the most relevant subject of affordability analysis: low-income households, a problem that worsens as income inequality increases (Rubin 2001). Third, the %MHI convention does not account for other essential costs of living. For meaningful evaluation of affordability, water and sewer prices as a percentage of total income are less relevant than their prices relative to disposable income, or market-adjusted effective buying power (Burke et al. 2018). Finally, the oft-invoked 2.0% or 4.5%MHI affordability threshold is not based on any theory, empirical analysis, or deliberative process. Applying these simple binary standards—either "unaffordable" or "affordable," depending on whether average bills fall above or below a threshold—masks important variation within and across utilities.

Seeking to establish a more meaningful and accurate methodology for measuring water and sewer affordability, Teodoro (2018) advanced a pair of alternative metrics: *AR* and *HM*. The *AR* accounts for basic household water needs and essential non-utility costs:

$$AR\ (\%) = (\text{Cost of Basic Water} + \text{Sewer Service}) \div (\text{Household Income} - \text{Essential Nonwater Costs}) \times 100$$

As defined here, *AR* reflects basic water and sewer costs as a share of disposable income. Assessing *AR* at the 20th percentile income (AR_{20}) rather than at median income focuses analysis on low-income households. Assessments of welfare economics typically identify the 20th percentile as the lower boundary of the middle class. These "working

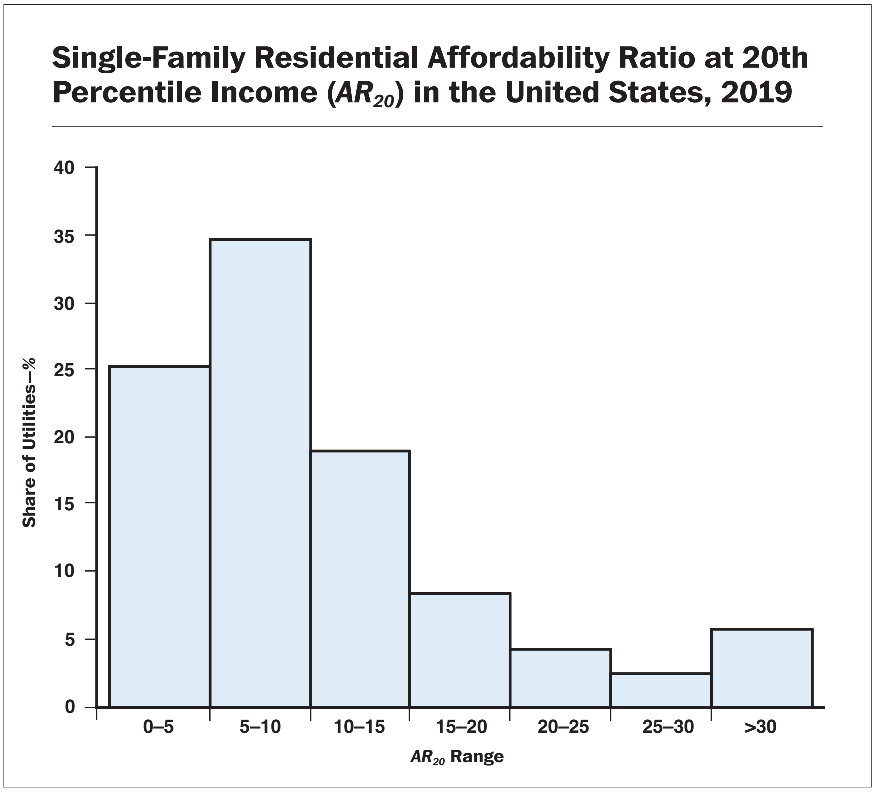


Figure 1

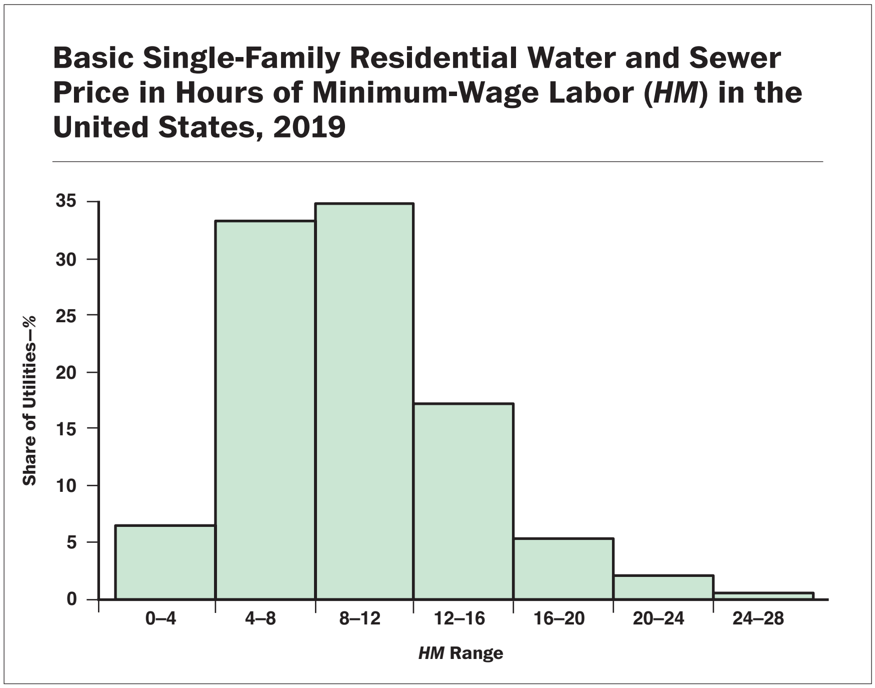


Figure 2

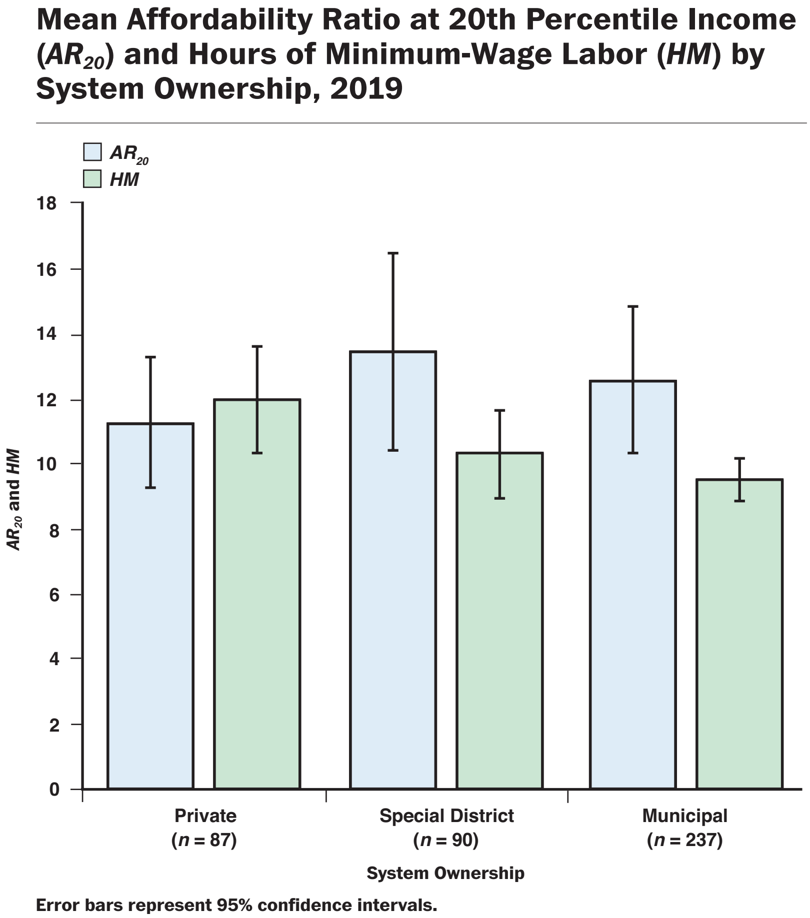


Figure 3

poor" households have very limited financial resources, but may not qualify for many income assistance programs. Basic household water and sewer costs expressed as *HM* is an intuitively appealing complementary metric.

Affordability Update

No comprehensive, national, publicly available data set on water and sewer rates in the United States currently exists. Therefore, we calculated affordability metrics using original rate data collected in the summer of 2019 from a randomized, stratified sample of water and sewer utilities in the United States. The data analyzed here constitute a representative sample of US water utilities and are used to calculate the affordability of basic single-family residential water and sewer service for low-income households. The 2019 sample was expanded from the 2017 sample, with 82 local government utilities randomly sampled from each of four size strata (up from 75 per stratum in 2017), and 22 privately owned utilities in each stratum (up from 16 in 2017).

Data Sources

The US Environmental Protection Agency's Safe Drinking Water Information System (SDWIS) served as a sampling frame for this study. The SDWIS contains basic system information and regulatory compliance data for each of the country's nearly 50,000 community water systems. We used the same sample of water utilities analyzed in the prior study, plus an additional 70 utilities from the same SDWIS sampling frame. With regard to sanitary sewer systems, in 67% of the cases a single organization provided both water and sewer services, and in the remaining cases we identified separate organizations that provided the sewer service for the communities identified in the SDWIS service area.

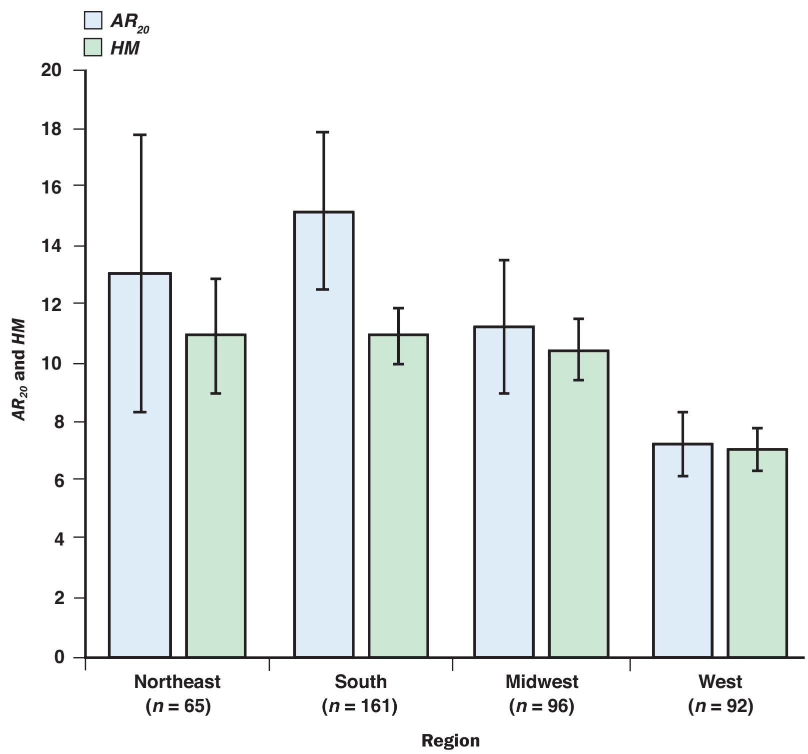
We gathered rate data by reviewing websites and directly contacting utilities by telephone, e-mail, and postal mail. Utilities with no sanitary sewer service in the area and systems that refused to provide rate information are excluded from the results presented here. The 399 utilities that constitute our final data set serve a combined population of almost 44 million.

The remaining data used in this study come from SDWIS, the US Census Bureau's 2017 American Community Survey (ACS) five-year estimates, applicable minimum wage data for 2019, and the 2016 and 2017

Resampling the same utilities that were analyzed in 2017 offers the opportunity to analyze how affordability changes over time.

US Bureau of Labor Statistics (BLS) Consumer Expenditure Surveys. We used the same method for matching demographic and income data to special district, county, and private utility jurisdictions as in the earlier study to ensure consistency between samples.

Mean Affordability Ratio at 20th Percentile Income (AR_{20}) and Hours of Minimum-Wage Labor (HM) by Region, 2019



Error bars represent 95% confidence intervals.

Figure 4

Affordability Measurement

We measured affordability using the two-pronged approach detailed in Teodoro (2018). The monthly price of basic single-family residential water and sewer service was calculated for a family of four at 50 gpcd, or 6,200 gallons per month. These prices were the numerators for AR_{20} and HM calculations. The 50-gpcd standard is a typical assumed minimal residential wastewater flow for purposes of sewer system design (Bowne et al. 1994), meant to reflect basic indoor water use. The Texas Water Development Board (2004) and California State Water Resources Control Board (2018) each have adopted 50 gpcd as a goal for basic indoor water use. The value of customer assistance programs was not included in price calculations, since our purpose is to measure affordability in absence of intervention. The sample-weighted average monthly price was US$39.99 for water and $43.72 for sewer, for a total of about $83.72.

Calculating HM required simply dividing monthly combined basic water and sewer prices by the locally applicable minimum wage. Calculating AR_{20} required estimating disposable monthly income for a family of four at the 20th percentile income in a given utility's service population. Data for gross income at the 20th percentile were drawn from the ACS' lowest-quintile upper limit. Essential nonwater expenditures were estimated with regression models that used BLS Consumer Expenditure Survey data to estimate expenditures on taxes, housing, health care, food, and home energy. Coefficients from those models were combined with ACS data on demographics and income for each utility to estimate essential expenditures at the 20th percentile income for a family of four. Subtracting these essential expenditures from 20th percentile income yielded the denominator for AR_{20}.

Limitations

Our study uses the best available data, but the AR_{20} calculations here rely on estimates of disposable income developed with regression models that use national- and metropolitan area–level consumer data. Such estimates are useful in depicting national conditions, but their accuracy may vary considerably for individual utilities. Similarly, the 50-gpcd basic water use level assumed in the analysis may not align with basic use in a particular utility. The study also does not account for water and sewer service *quality*. Finally, the two-wave time series (2017 and 2019) limits our ability to infer trends in affordability. We hope in the future to capture changes in these utilities over a longer period.

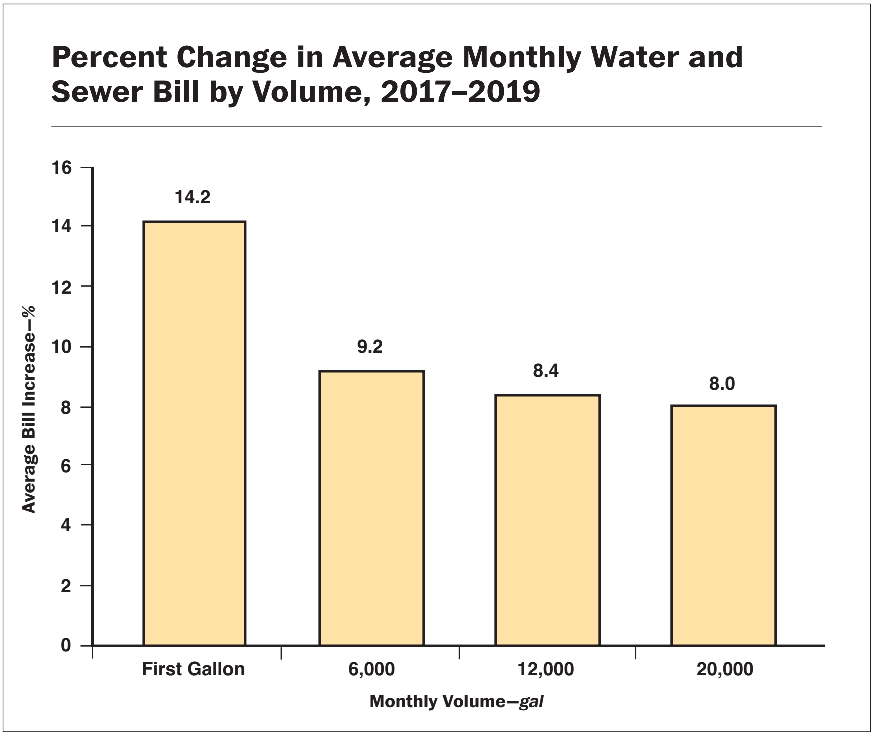


Figure 5

Water and Sewer Affordability in the United States, 2019

Figures 1 and 2 report the overall distribution of AR_{20} and *HM*, respectively. The weighted national average AR_{20} is 12.4%, with values ranging from 1.4% to greater than 100%; for analytical purposes, AR_{20} values are capped at 100.0%. Values of *HM* range from 1.6% to 27.0%, with a weighted average of 10.1%.

Affordability by Ownership

Differences in rates between publicly and privately owned utilities are subjects of frequent interest. Figure 3 depicts average AR_{20} and *HM* by three types of ownership (private, municipal government, and special districts). Average AR_{20} does not vary significantly by ownership, but the average private utility's *HM* is a statistically and substantively significant 2.5 hours greater than that of the average municipal utility. In other words, paying for basic monthly water and sewer service requires an average of 2.5 more hours of minimum-wage labor for customers of a private utility than for those of a municipal utility.

The effect of essential expenditures and 20th percentile income can be seen in Figure 3, where privately owned utilities have a lower average AR_{20} than municipal utilities or special districts. The main reason for this counterintuitive result is that 20th percentile income is higher on average for customers served by privately owned utilities compared with those served by municipal and special district utilities. These underlying differences help explain why privately owned systems' average AR_{20} is relatively low, which is desirable, even as their average *HM* remains relatively high.

Figure 4 shows affordability by US region. Average affordability remains roughly similar across regions, except for in the West, where basic water and sewer services are considerably more affordable on average.

Changes in Prices and Rate Structures, 2017–2019

Resampling the same utilities that were analyzed in 2017 offers the opportunity to analyze how affordability changes over time. We calculated changes over the two-year period by subtracting the mean weighted averages in 2017 from the mean weighted averages in 2019. The mean weighted change in total water and sewer charges is +$4.07 in 2019, which can be broken down into a +$3.23 mean change in water charges and a +$0.84 mean change in sewer charges. A handful of utilities experienced reductions in monthly water and sewer prices at 6,200 gallons, *HM,* and AR_{20}, but these were rare and mostly the result of changes in rate structure.

To better understand the effects of changing pricing schemes, we analyzed the *first-gallon prices* for water and sewer service. The first-gallon price is what a customer pays for using any water at all: any fixed charges plus the price of the first volumetric unit of water and sewer service. For example, if there is a $20 fixed charge for water service and the first unit of water is $2, then the first-gallon price for water service is $22. Figure 5 shows the percentage change in an average combined first-gallon water and sewer bill, as well as percentage change in the total bill at 6,000, 12,000, and 20,000 gallons. As Figure 5 shows, the first-gallon water and sewer price increased at a far greater rate (14.2%) than the bills at moderate to high volumes. By contrast, the average bill at 20,000 gallons increased just 8.0%. The distribution of total revenue across volume levels likely varies considerably across utilities, but taken together, these results show how changes in rate structure have shifted water and sewer systems' relative cost burdens from high-volume to low-volume customers as part of the systems' pricing strategies (Walton 2018).

Short-Term Affordability Trends

Subtle but important shifts in the distribution of incomes and expenditures contributed to a worsening national affordability picture overall. Changes in 20th percentile income and essential expenditures from 2017 to 2019 were uneven. Over this two-year period, 20th percentile income crept slightly higher, but the distribution of essential expenditures shifted markedly higher: the share of utilities with essential expenditures under $750 per month fell from 37.8% to just 15.7%. Meanwhile, the share of utilities with monthly essential expenditures ranging from $750 to $1,250 jumped from 51% to more than 70%. These results reflect uneven economic effects that include sluggish income growth at the low end of the distribution and rising costs of living for low-income households.

Change in Mean Affordability Ratio at 20th Percentile Income (AR_{20}) and Hours of Minimum-Wage Labor (*HM*) by System Ownership

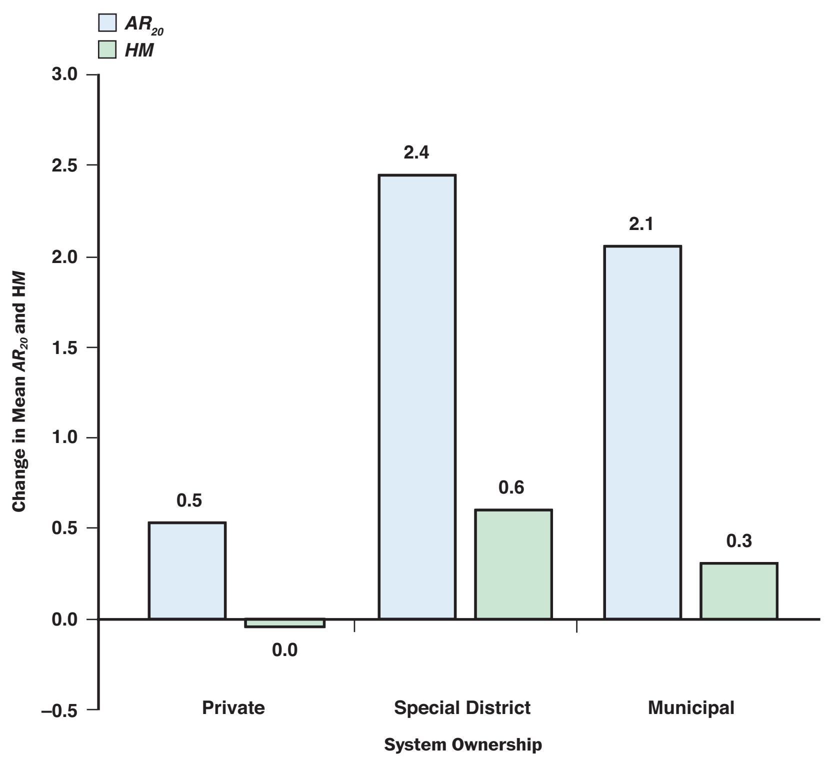


Figure 6

These changes affect water and sewer affordability for low-income households in ways that may not be apparent from analyses focused on median incomes. Between 2017 and 2019, *HM* increased slightly, but AR_{20} increased sharply from 10.9% to 12.4%. Figure 6 shows that municipal utilities and special districts saw greater average increases in AR_{20} (+2.1% and +2.5%, respectively), compared with those for private utilities (+0.5%). Changes in *HM* varied less by ownership (Figure 6), with special district *HM* increasing by +0.6 hours and municipal utilities by +0.3 hours, but private utilities experiencing a slight *decrease* in *HM* (–0.04 hours). Figure 7 shows that the South and Northeast experienced the greatest mean changes in AR_{20} (+3.3% and –2.0%, respectively), while the West increased by 1.3% relative to 2017. The Midwest experienced the greatest average change in *HM* at approximately +1.3 hours in 2019, while other regions had experienced only slight increases since 2017.

Putting the Findings in Context

Our main findings—that households at the local 20th percentile income level must spend an average of 12.4% of their disposable income and/or work 10.1 hours at minimum wage to pay for basic monthly water and sewer service—indicate a marked deterioration of affordability conditions in the United States compared with 2017.

Drivers of Declining Affordability

The main drivers behind the increases in AR_{20} between 2017 and 2019 were increases in total water and sewer charges, increases in essential expenditures, and stagnant or—more alarmingly—decreasing 20th percentile

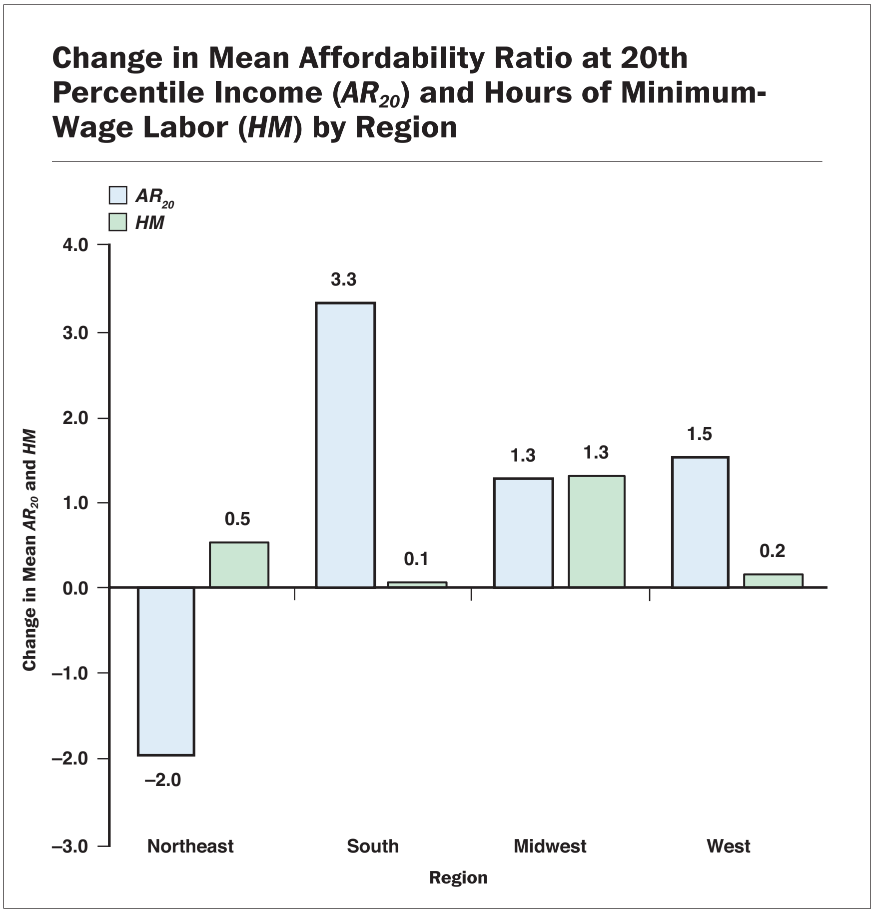


Figure 7

incomes in some cases. The increase in essential expenditures was especially meaningful in communities where essential expenditures were already high and the 20th percentile income was already low. Even small changes in water and sewer charges can have a substantial impact on affordability where disposable income is very low. This reality is reflected in the far more dramatic rise in AR_{20} (+2.7%), compared with the more modest increase in *HM* (+0.6 hours).

Implications

What is "affordable" is ultimately a normative question and invites a philosophical inquiry beyond the scope of this study. Although no specific level of AR_{20} or *HM* defines affordability objectively, Teodoro (2018) suggests values of AR_{20} less than 10% and *HM* less than eight hours as rules of thumb to guide policy consideration. By these guidelines, 60% of the sampled utilities are affordable as measured by AR_{20} and 39% are affordable according to *HM*.

We close with a reminder that comparing affordability across utilities is not appropriate for purposes of setting policy in any specific utility, as local infrastructure and socioeconomic conditions vary in ways that can make comparisons deceptive. A national profile of affordability is useful for developing broad regulatory strategy or assessing the water sector nationally, but affordability is fundamentally a household-level phenomenon, so cross-utility comparisons are not especially useful for ratemaking or developing an affordability plan for a given utility. The prices of basic water and sewer service in Denver, Colo., and Danbury, Conn., are not relevant for a low-income family in Davis, Calif. Rather than comparing themselves with others, utility leaders should seek to maintain affordability levels that are consistent with their own communities' goals and values.

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AWWA Resources

- **Water Costs and Affordability in the United States: 1990 to 2015. Rubin SJ. 2018. *Journal AWWA.* 110:4:48. https://doi.org/10.1002/awwa.1062**
- **Consider Water and Sewer Rate Affordability. Qureshi N, Hanson R. 2019. *Opflow.* 45:3:10. https://doi.org/10.1002/opfl.1156**
- **Model Water Utility Affordability Programs. Blake BL, Brown GA, Rothstein E. 2017. *Journal AWWA.* 109:8:30. https://doi.org/10.5942/jawwa.2017.109.0103**
- **Deteriorating Water Distribution Systems Affect Public Health. Vacs Renwick D, Rotert K. 2019. *Opflow.* 45:9:12. https://doi.org/10.1002/opfl.1246**
- **Cost Recovery and Affordability in Small Drinking Water Treatment Plants in Alberta, Canada. Janzen A, Achari G, Dore MHI, et al. 2016. *Journal AWWA.* 108:5:E290. https://doi.org/10.5942/jawwa.2016.108.0047**

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