BUREAU OF RECLAMATION

Estimating Household Ability to Pay for Municipal Water Services

Technical Memorandum M&S-2022-G2388
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Abbreviations

ATP – ability to pay

ACS – American Community Survey

BLS – U.S. Bureau of Labor Statistics

CDP – census designated place

CPI – consumer price index

EPA – U.S. Environmental Protection Agency

MAD – median absolute deviation

M&I – municipal and industrial

OLS – ordinary least squares

Reclamation – U.S. Bureau of Reclamation

TSC – Technical Service Center

1.0 Introduction

Financial feasibility is based on the ability to pay the costs associated with an alternative. If water users have the financial resources to pay the full cost, including the upfront cost (e.g., construction) and ongoing costs (e.g., operation, maintenance, and replacement), then the alternative is considered financially feasible. For municipal water systems, these costs are generally paid by households through monthly user charges. Financing may also be available from grants, capital reserve funds, or commercial and industrial water users. If additional sources of funding are available, these can be added to the ability to pay of households. That said, the primary source of funding stems from water users, so here the focus is on estimating household ability to pay (ATP) for municipal water services. This reflects the financial resources that households have available to pay for both existing and new water services. This document provides an overview on the methodology and necessary steps for estimating household ATP. An estimation tool is also provided, allowing the user to estimate household ATP anywhere in the 17 western states using readily available data for the area of interest.

1.1 Motivation

Financial feasibility is an important consideration for municipal water providers and local, state, and federal governments. Providers need to know how much water users can pay towards the cost of a water supply project and how that compares to the total cost of different alternatives. Several federal laws related to the protection of water resources and provision of clean water supplies require consideration of affordability as part of the evaluation process. Some of these laws include the Safe Drinking Water Act, the Clean Water Act, the Toxic Substances Control Act, the Asbestos Hazard Emergency Response Act, the Comprehensive Environmental Response, Compensation and Liability Act, and the Resources Conservation and Recovery Act. The U.S. Environmental Protection Agency (EPA) has included affordability criteria in their guidelines for evaluating the cost of compliance with federal laws, assessing financial responsibility, and establishing penalties and fines when setting water quality and service standards.

Household ability to pay is broadly defined as the maximum amount that households can afford for water services. While the concept of ATP is fairly straightforward, determining the "maximum amount" that households can afford and estimating ATP is not, so a wide range of methods have been used to evaluate ATP. In 1980 the EPA completed a Water Utility Financing Study that was initiated as a result of a 1977 Congressional requirement that EPA study the costs of complying with new drinking water regulations (EPA, 1980). The study evaluated the cost of water services to households and concluded that an annual user cost divided by household income of 1.5% to 2.5% was of questionable affordability and a ratio greater than 2.5% was not affordable (EPA, 1980). Subsequent EPA studies on the affordability of the 1986 Safe Drinking Water Act estimated a threshold of 2% of median household income, and the EPA concluded that an average user charge per household greater than 1% should require additional financial resources to reduce the percentage below 1% (EPA, 1990; EPA, 1993). Furthermore, the EPA determined that short-run increases beyond 25% of the current rate would create financial hardship for water users (EPA, 1990).

Up to this point, the EPA studies on affordability focused primarily on wastewater treatment. The EPA established affordability criteria for drinking water in the 1996 amendments to the Safe Drinking Water Act, allowing small water supply systems to use less extensive water treatment technology if the most effective technology was not considered affordable. The EPA established a 4% of median household income benchmark for affordability; 2% for wastewater treatment and 2% for drinking water supplies. This benchmark was later amended to 4.5% to allow 2.5% for drinking water expenses. For more details on the history of EPA's evaluation of affordability, see the U.S. Bureau of Reclamation's (Reclamation) technical memorandum (EC-2009-02) Evaluating Economic and Financial Feasibility of Municipal and Industrial Water Projects (Reclamation, 2009). Other agencies have used similar approaches as the EPA, for example, the Department of Housing and Urban Development has used an affordability threshold of 1.3% of household income for water payments and 1.4% for sewer payments (Reclamation, 2009).

The EPA affordability threshold is not a true measure of affordability but is instead based on the acceptability of fee increases. Using ratios of costs to income to determine affordability ignores other important factors related to paying for water system improvements. As such, the EPA uses a second level of analysis to evaluate financial capability, including metrics of debt capacity, access to capital, and indicators of socio-economic conditions for a community, such as the poverty rate, population growth, and employment.[1] For early municipal and industrial (M&I) ATP studies done by Reclamation, the EPA drinking water affordability benchmark of 2.5% of median household income served as the starting point. However, this benchmark serves as only one metric among many for evaluating financial capability, and it is intended to serve as a binary (yes/no) criteria to evaluate water service costs relative to household income, not as a means to estimate the total resources that a community has available for financing new water projects, as Reclamation generally aims to do when evaluating M&I ATP. As such, several shortcomings have been identified with using the EPA 2.5% of median household income benchmark to generate a monetary estimate of ATP for a community of interest. In particular:

1. The approach evaluates gross household income, rather than accounting for necessary expenditures and focusing on discretionary household income.

2. The method ignores differences in cost of living, which affects discretionary income.

3. The approach does not account for the importance of poverty or give special attention to low-income households, while affordability affects these households most.

4. The use of 2.5% as the ATP threshold is arbitrary and not based on observed household behavior or actual water payments.

These shortcomings are discussed in more detail in EC-2009-02, and Reclamation's guidance for irrigation ability to pay analysis (PEC 11-01) also outlines a household budgeting methodology for household water use in Section 8(A). To address the shortcomings outlined above, a household ATP estimation methodology has been developed by the Economic Analysis Group at

[1] See EPA (1997) for their original guidance and EPA (2023) for the most recent guidance on financial capability.

Reclamation's Technical Service Center (TSC) consistent with EC-2009-02 and PEC 11-01. This document summarizes the methodology and provides an estimation tool that can be used to estimate household ATP using readily available data for an area of interest. This allows for a rigorous analysis and consistent estimation of household ATP that reflects the financial resources available for municipal water services in a particular study setting. The methodology outlined in this document provides a monetary estimate of ATP based on observed water payments while focusing on discretionary income, accounting for poverty and low-income households, and using both household and community level information. The data, model, and tool will be maintained by the TSC Economic Analysis Group and updated as more data becomes available.

2.0 Estimating Ability to Pay

Ability to pay is defined here as the maximum amount that households could pay for domestic water services given their income and after accounting for other necessary expenditures. After subtracting existing water service costs, the amount remaining reflects the "net ATP" or the amount available for financing new water supply projects. To calculate net ATP, total ATP must first be estimated. This is done by focusing on discretionary household income, which reflects gross income minus necessary expenditures on goods and services such as housing, food, clothing, transportation, and healthcare. To estimate necessary household expenditures at the community level, a regression model is developed based on household characteristics and socioeconomic conditions, such as income, household size, home ownership, and population size. Entering this information into the model provides an estimate of necessary expenditures for a typical household in the area of interest. That said, this estimate will not reflect differences in cost of living, so an adjustment is made based on a cost-of-living index in the study area.

After the estimate of necessary expenditures is adjusted for cost of living, this is subtracted from median household income to derive an estimate of discretionary household income in the area of interest. This serves as the basis for calculating ATP, rather than gross household income. The next step involves multiplying discretionary income by an ATP threshold reflecting the maximum that households can afford for water services. Instead of simply applying the 2.5% threshold established by the EPA, water payment data was collected for communities in each of the 17 western states to derive a unique ATP threshold for each state. This threshold is calculated based on a statistical measure of dispersion around the median. The median is used to avoid bias from outliers. This provides an objective ATP threshold that is rooted in observed payment data, which also allows the ATP threshold to change over time as underlying factors change.

At this point, the approach addresses 3 of 4 shortcomings identified with the EPA 2.5% benchmark. The remaining shortcoming – not accounting for poverty or low-income households – is also addressed. This is done by calculating a "poverty adjustment" that is applied to the ATP threshold. This adjustment is based on a comparison of water payments in communities with high poverty to the rest of households. This is then used to adjust the ATP threshold based on the poverty rate in the area of interest. The approach presented here ultimately provides a site-specific estimate of ATP that addresses the four shortcomings of the EPA 2.5% benchmark. An estimation tool is provided to make this approach readily available for Reclamation and others to estimate ATP anywhere in the 17 western states based on publicly available data.

2.1 Regression Model for Necessary Household Expenditures

Necessary expenditures are broadly defined as expenditures on goods and services necessary to ensure a safe, secure, and sustainable household. Here necessary expenditures are defined to include seven key categories of spending: housing, property taxes, food, clothing, transportation, healthcare, and payments for personal insurance and pensions. Spending on housing includes all utilities other than water. An ordinary least squares (OLS) regression of necessary household expenditures is developed in order to estimate discretionary income, which provides a consistent basis for determining the financial resources available to households to pay for water service, after all other necessities are paid for. The model includes variables that influence the level of necessary household expenditures. The regression model is estimated at the household level and applied at the community level to estimate necessary expenditures for a typical household. A cost-of-living adjustment is then used to account for differences across communities.

A necessary expenditure model is estimated at the household level using survey data from the U.S. Bureau of Labor Statistics (BLS) Consumer Expenditure Public Use Microdata for 2019 and 2020.[2] A structural difference was identified between 2019 and 2020, likely due to the Covid-19 pandemic, so a binary variable *Data 2020* is included in the model to account for differences between these years. The dataset includes households across the entire United States, so a binary variable *West* is included to identify whether the household is located in the 17 western states where Reclamation operates, or the rest of the country. Several variables and functional forms were explored, but the variables and regression specification presented here is the latest iteration of the model. As more data becomes available, this model is expected to be further refined. For example, the current model relies on cross-sectional data, but future regressions could explore a time series or even panel analysis, once data permits.

To estimate necessary expenditures, variables that are expected to influence expenditures were tested in the model. Table 2.1 defines the explanatory variables included in the final model and the expected sign of the coefficients. This includes household income (before taxes), household size, home ownership, and population size. Note that these are defined at the community level, while the regression model is estimated at the household level. For example, home ownership is measured as a yes/no (1/0) binary variable at the household level, while at the community level this variable reflects the average percentage of the population that owns their home. As mentioned, a binary variable *West* is included to address geographical differences and *Data 2020* to address economic differences between 2019 and 2020 associated with the Covid-19 pandemic. The variable *Data 2020* allows the model to provide estimates under "pre-pandemic" conditions.

Several additional variables not listed in Table 2.1 were tested, specifically, children under 18, mortgage payment, Reclamation regions, health insurance, urban/rural, building type, family type, education, retirement (age), and gender. While potentially theoretically relevant, these variables were not found to be statistically significant and were excluded from the final model to avoid unnecessary complexity. In many instances these variables are highly correlated with other variables, meaning their effects are already captured within the model to some extent. For example, there is a high correlation between children under 18, family type, and household size; mortgage payment, building type, and home ownership; and urban/rural and population size. As

[2] BLS consumer expenditure survey data can be found at https://www.bls.gov/cex/.

more data becomes available, these variables and others should be further explored. The variables with the strongest theoretical relevance are included in the final model.

Table 2.1 – Variable Definitions and Expected Sign

Variable	Definition	Expected Sign
Household Income	Median household income ($10,000's).	Positive
Household Income Squared	Median household income ($10,000's), squared.	Negative
Household Size	Average household size.	Positive
Household Size Squared	Average household size, squared.	Negative
Home Ownership	Percent of the population that owns their home.	Positive
Population Size [a]	Total community population specified as a categorical variable, where 1=less than 125,000; 2=125,000-329,999; 3=330,000-1.19m; 4=1.2m-4m; and 5=more than 4m.	Positive
West	The community is in the 17 western states (yes/no).	Unknown
Data 2020	Data is from the 2020 BLS survey.	Negative

[a] This variable is specified as a categorical variable in the BLS survey. The categories are flipped here so that a positive coefficient is expected.

Necessary expenditures are expected to increase with *Household Income* and *Household Size*, but the relationship is not expected to be constant, so these variables enter the model with quadratic terms to allow for a non-linear relationship. As highlighted in Table 2.1, a negative sign is expected for the quadratic terms, indicating that necessary expenditures are expected to increase with income and household size, but at a decreasing rate. This is consistent with economic theory and previous iterations of the necessary expenditure model. *Home Ownership* is expected to have a positive sign due to additional expenses required to keep up a home, which are typically not incurred by renters.

Population Size is expected to have a positive impact on necessary expenditures because a larger and more dense area will have a greater demand for goods and services and potentially create a shortage. This would result in upward price pressure on goods and services in higher population areas. The sign on the variable *West* is unknown, but this is important to include to account for potential differences between the 17 western states and the rest of the country. The final variable, *Data 2020*, is expected to have a negative sign since the Covid-19 pandemic reduced household spending on all goods and services, including necessary expenditures.

The BLS consumer expenditure data is provided quarterly, so all prices are adjusted to the fourth quarter of 2020. The dataset includes a total of 1,110 household observations after dropping observations with necessary expenditures that exceed total income and/or total expenditures. The former is likely associated with short-term borrowing that would not be expected to persist in the long run, and the latter could be due to potential error in the BLS data. Dropping these observations did not affect the model estimates but was deemed necessary for theoretical reasons (e.g., it is not feasible for necessary expenditures to exceed income over the long run).

Table 2.2 provides the summary statistics for the variables included in the regression model. The summary statistics are at the household level, while Table 2.1 defines the variables at the community level since the regression model is applied at the community level to estimate necessary expenditures for a typical household in that community. This means the average shown below reflects the percentage of "yes" responses across households for the binary (0/1) variables (e.g., *Home Ownership*), while at the community level these variables represent percentages for the community of interest (e.g., 80% home ownership).

Table 2.2 – Summary Statistics for Regression Variables

Variable	Average	Minimum	Maximum	Standard Deviation
Necessary Expenditures [a]	\$2.34	\$0.05	\$18.69	\$2.51
Household Income [a]	\$9.21	\$0.42	\$54.13	\$8.12
Household Income Squared [a]	\$150.68	\$0.17	\$2,930.48	\$305.75
Household Size	2.36	1	8	1.34
Household Size Squared	7.36	1	64	8.72
Home Ownership	0.72	0	1	0.45
Population Size	3.23	1	5	1.31
West	0.30	0	1	0.46
Data 2020	0.37	0	1	0.48

[a] Monetary variables are 2020\$ and reported in \$10,000's. For *Household Income Squared*, this entails household income in \$10,000's before being squared, meaning this variable is reported in \$100,000,000's.

Variables were explored in various functional forms, testing polynomials, natural log transformations, and interaction variables. A natural log transformation for the dependent variable (*Necessary Expenditures*) is used for the final model. The coefficient estimates are therefore interpreted as a percent-change in necessary expenditures (e.g., a coefficient of 0.2 implies a 20% change in necessary expenditures from a one-unit change in the explanatory variable). Table 2.3 presents the estimated coefficients for the final model specification. All estimates are statistically significant at the 10% level or better. The model has an R-squared of 0.74, indicating the variables explain about 74% of the variation in necessary expenditures.

Cross sectional data often suffers from heteroskedasticity, which means there is a systematic change in the variance of the model residuals (difference between the observed value and the predicted value) across the range of measured values. This has no impact on the coefficients but does affect standard errors and statistical significance. Heteroskedasticity can be identified by plotting the model residuals and visually checking if they appear random, or formally testing using a statistical test such as a Breusch-Pagan test or White test. All of these indicated the presence of heteroskedasticity. A natural log transformation of the dependent variable is one way to correct this, but this does not always work, as was the case here. As such, the robust standard errors are reported in the table, which reflect a correction to provide unbiased standard errors under heteroskedasticity.

Table 2.3 – Regression for Natural Log of Necessary Household Expenditures

Variable	Coefficient Estimate
Household Income	0.103*** (0.007)
Household Income Squared	-0.0015*** (0.0002)
Household Size	0.200*** (0.051)
Household Size Squared	-0.022*** (0.008)
Home Ownership	0.096** (0.039)
Population Size	0.035*** (0.013)
West	0.079** (0.036)
Data 2020	-1.574*** (0.034)
Intercept	8.877*** (0.084)

Robust standard errors shown in parenthesis. *n*=1,110, *R-Squared*=0.7412

*10% significance, **5% significance, ***1% significance

Based on these coefficient estimates, household necessary expenditures can be estimated at the community level using Equation (1) shown below. Since the dependent variable is log transformed, the right-hand-side of the equation must be exponentiated to estimate necessary expenditures in monetary terms. Note that it is important to enter the variables according to the definitions shown in Table 2.1. For example, *Population Size* enters as a categorical variable from 1 to 5, and *Household Income* is in $10,000's. Also note that *Data 2020* is excluded (variable set to 0) so that the model provides estimates under "pre-pandemic" conditions.

$$\textit{Necessary Expenditures} = \exp[8.877 + 0.103(\textit{Household Income}) - 0.0015(\textit{Household Income})^2 + 0.2(\textit{Household Size}) - 0.022(\textit{Household Size})^2 + 0.096(\textit{Home Ownership}) + 0.035(\textit{Population Size}) + 0.079(\textit{West})] \quad (1)$$

Looking at *Household Income*, the model indicates that every $10,000 increase in income increases necessary expenditures by about 10.3%, while the negative quadratic term indicates that this effect decreases as income increases. This implies that the marginal effect is non-linear and depends on the level of income, decreasing as income increases. Put differently, earlier units of income increase necessary expenditures more than later units of income. For *Household Size*, the model indicates that an additional person in the household increases necessary expenditures by 20%, while the negative quadratic term indicates that each additional person has a smaller effect than the last. This implies that the marginal effect is non-linear and depends on household size, decreasing as household size increases. Put differently, earlier occupants in a household increase necessary expenditures more than later occupants.

Looking at *Home Ownership*, those who own their home on average incur 9.6% more in necessary expenditures, which is likely due to additional expenses required to keep up a home, and partly due to most homeowners having a mortgage payment. *Population Size* is another important predictor of necessary expenditures, with expenditures increasing with population size. This is due to higher prices in more densely populated areas. Since population is specified as a categorical variable, the coefficient indicates that necessary expenditures increase by about 3.5% when going from one population category to the next. Each population category was tested as a binary variable (excluding one as the reference group) to examine if this effect differed between population categories. The coefficient estimates proved to be similar, so a single categorical variable was deemed appropriate.

The coefficient estimates for *West* and *Data 2020* are both statistically significant, but these variables are primarily included to avoid omitted variable bias. For Reclamation purposes and any estimate of ATP in the 17 western states, the variable *West* should be "turned on" (set to 1). The coefficient indicates that households in the West incur on average 7.9% more in necessary expenditures. The variable *Data 2020* allows the 2020 BLS survey data to be used with 2019 data without biasing the estimates. This increases the number of observations for the regression analysis and improves robustness of the estimates. The coefficient suggests that the Covid-19 pandemic decreased necessary expenditures by about 157%. To estimate ATP under "pre-pandemic" conditions, *Data 2020* is set to 0.

2.2 Cost of Living Adjustment

The regression model estimates necessary expenditures primarily based on household characteristics, so a cost-of-living adjustment is needed to account for important differences across communities. Put differently, the variables in the regression model are only able to explain a bit under half of the variation in necessary expenditures, and these mostly reflect household factors. A large part of the remaining variation is likely due to differences in the cost of living across communities, with notable differences in the cost of housing, property taxes, food, clothing, transportation, healthcare, and payments for personal insurance and pensions.

Community differences in cost of living could not be addressed in the regression model due to limitations with the BLS expenditure data, so a cost-of-living index is used to adjust the estimate of necessary household expenditures. This increases the estimate of necessary expenditures in communities with a relatively high cost of living and decreases the estimate in areas with a relatively low cost of living. With the index having a base value of 100 (national average), *Adjusted Necessary Expenditures* are calculated as:

$$\textit{Adjusted Necessary Expenditures} = \textit{Necessary Expenditures}\left(\frac{\text{Cost of Living Index}}{100}\right) \quad (2)$$

Sperling's Best Places provides a cost-of-living index for each community in the United States and is used to adjust the estimates provided by the regression model.[3] This index is not necessarily considered a precise index for cost of living, but it is readily available, regularly updated, and consistent across a wide range of communities. When estimating ATP for a particular area, it is suggested that the analyst use the most recent Sperling's Best Places index for their area of interest to tailor the estimate to the study area.

2.3 Discretionary Household Income

Discretionary household income reflects the income remaining after accounting for necessary household expenditures. As covered in the previous section, it is important to first adjust necessary expenditures for differences in cost of living. After doing so, *Adjusted Necessary Expenditures* is subtracted from *Household Income* to calculate *Discretionary Income* as:

$$\textit{Discretionary Income} = \textit{Household Income} - \textit{Adjusted Necessary Expenditures} \quad (3)$$

Discretionary Income is compared with existing water payments to evaluate the proportion of discretionary income that goes towards water services. This is done for a total of 1,831 communities across the 17 western states. After determining the proportion of discretionary income going towards water services in each community, the communities within each of the 17 states are evaluated to establish a unique ATP threshold for each state.

[3] The most recent cost of living indices can be found at https://www.bestplaces.net/cost-of-living/.

2.4 Ability to Pay Threshold by State

Recall that ATP is defined here as the maximum amount that households could be expected to pay for domestic water services. The key question is then what constitutes a reasonable "maximum amount" that households could afford? The "maximum amount" is not intended to reflect how much income simply remains after accounting for all other expenses (a more literal interpretation of "maximum") but is instead intended to reflect a maximum reasonable expectation for households to spend on water services without imposing hardship. This is inherently a normative question, so existing water payments and a statistical measure of variation is used to establish ATP thresholds as objectively as possible.

Using the average or median water payment would likely understate ATP since many communities already pay above this amount, so the median plus the median absolute deviation (MAD) is used to define the ATP threshold. The MAD is a simple way to quantify variation where half of the observed values are closer to the median than the MAD, and half are further away. The median is used since it is not affected by outliers and is the best indicator of central tendency when the distribution is skewed. This provides a statistical approach to defining the ATP threshold that is rooted in observed payment data, which also allows the ATP threshold to change over time as underlying factors change.

Using observed water payments across communities (i), an ATP threshold is calculated for each state (j) based on the median water payment plus the MAD for communities in that state. The MAD is defined as:

$$MAD_j = median_j\,(|X_i - median_j\,(X)|) \qquad (4)$$

The term $|X_i - median_j\,(X)|$ is the absolute value of the i^{th} observation (community) minus the median of all communities in state j. The ATP threshold is then calculated for each state as:

$$ATP_j = median_j\,(X) + MAD_j \qquad (5)$$

This threshold is used to define the maximum proportion of household discretionary income that could be expected to go towards water services for communities within each state. Table 2.4 shows the ATP threshold calculated for each of the 17 western states.

Table 2.4 – Estimated ATP Thresholds for the 17 Western States

State	ATP Threshold
Arizona	1.92%
California	2.59%
Colorado	2.56%
Idaho	2.12%
Kansas	2.15%
Montana	1.97%
Nebraska	0.95%
Nevada	1.96%
New Mexico	2.22%
North Dakota	1.72%
Oklahoma	1.58%
Oregon	1.62%
South Dakota	1.44%
Texas	1.74%
Utah	1.60%
Washington	1.60%
Wyoming	1.49%

These thresholds come from estimating discretionary income across all 1,831 communities with available water payment data.[4] This required estimating necessary expenditures for all communities based on the regression model shown in Equation (1). This was done using 5-year estimates from the U.S. Census Bureau American Community Survey (ACS).[5] The 5-year estimates are deemed preferable to the 3-year and 1-year estimates due to data availability for smaller areas, as well as less influence from sporadic annual variation. After estimating necessary expenditures for each community, a cost-of-living adjustment was made based on Equation (2) and cost of living indices from Sperling's Best Places. Discretionary income was then calculated for each community according to Equation (3), and Equations (4) and (5) were used to calculate the thresholds shown in Table 2.4.

Recall the EPA threshold for affordability which is defined as 2.5% of gross household income. Most of the thresholds in Table 2.4 fall below 2.5%, while some states have thresholds above this. That said, it is important to keep in mind that the thresholds in the table are based on (and applied to) discretionary household income, not gross household income, and a cost-of-living adjustment is included. This is important when comparing approaches and means that the 2.5% threshold should not be directly compared with the thresholds shown in Table 2.4.

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[4] Water payment data was gathered by Reclamation from municipal and local government websites, as well as from directly contacting various municipal systems. The water payment data spans several years and was indexed to 2020$. Contact the TSC Economic Analysis Group for more details on this data.

[5] ACS data is available at https://www.census.gov/programs-surveys/acs/data.html.

2.5 Poverty Adjustment

The thresholds presented in the previous section focus on discretionary income, account for differences in cost of living, and are established based on observed water payments and a statistical measure of dispersion across communities within each state. Another key consideration, and shortcoming of the EPA 2.5% benchmark, is to account for poverty and low-income households. To do so, a poverty adjustment is calculated and applied based on the poverty rate in the community of interest. The higher the poverty rate, the more the ATP estimate is adjusted downward.

To calculate the poverty adjustment, poverty data was evaluated for all communities in the 17 western states with available data, reflecting a total of 9,163 communities. The median poverty rate was found to be 11% and the MAD for the poverty rate was 7.2%. The median plus MAD poverty rate of 18.2% is used as the threshold to identify high poverty communities. Using this threshold, water payments for the communities above and below this threshold were compared to calculate a poverty adjustment. Approximately 28.1% of communities fall above this threshold, with a median water payment of 1.94% for high poverty communities and a median payment of 1.35% for the remaining communities. The poverty adjustment is calculated as the difference between these amounts, which is 0.59%. Shown below, an “Adjusted ATP” threshold is calculated by subtracting this amount from the relevant ATP threshold in Table 2.3, proportional to the poverty rate in the area of interest.

$$\text{Adjusted ATP} = (1 - \text{Poverty Rate})\text{ATP}_j + \text{Poverty Rate}\,(\text{ATP}_j - 0.59\%) \qquad (6)$$

Intuitively, low-income households tend to pay a greater proportion of discretionary income on water services, so this adjustment reflects the amount necessary for a typical low-income household to pay the same proportion as other households. In some cases, low-income households may already be paying an amount greater than this.

2.6 Overview of Ability to Pay Estimation

As outlined in the previous sections, there are several steps required to estimate household ATP for an area of interest. This can be carried out by an analyst based on the information presented above. That said, an estimation tool is also provided (discussed more below), which allows the analyst to estimate ATP for their study area by gathering and entering key input data for the tool to conduct the necessary calculations. This section briefly summarizes each step in the estimation process. This is important for an analyst performing the estimation without the tool, as well as an analyst using the tool so that they can appropriately interpret the estimates provided by the tool.

The first step to estimating household ATP is to estimate necessary household expenditures for the area of interest. In many cases the study area may align with established community boundaries, such as a town, city, county, or census designated place (CDP) with readily available data for that area. If the study area spans several smaller areas or data is not available for the study boundary, then it is important that the input data used is representative of the area of interest. This may imply using the average, or perhaps the population-weighted average, etc.

across the smaller areas with available data. To estimate necessary household expenditures, data is needed for the variables used in the regression model (Table 2.1), specifically, median household income, average household size, home ownership, and population size. The ACS 5-year estimates are recommended. Plugging this information into Equation (1) provides an estimate of household necessary expenditures.

The next step is to tailor the estimate to the community of interest by adjusting the estimate of necessary expenditures for differences in the cost of living using Equation (2). This accounts for the fact that the cost of housing, property taxes, food, clothing, transportation, healthcare, and payments for personal insurance and pensions are unique to the area of interest. Sperling's Best Places provides a readily available cost of living index for each community in the United States. Discretionary income is then calculated as median household income minus adjusted necessary expenditures according to Equation (3). Finally, the thresholds shown in Table 2.4 are applied to the estimate of discretionary income, but it is important to first adjust the threshold for low-income households based on the poverty rate in the area of interest using Equation (6). Applying this adjusted ATP threshold will then provide an estimate of ATP per household per year within the study area.

To determine total annual ATP for the area of interest, the estimate of ATP per household can be multiplied by the number of households in the study area (i.e., affected by the alternative). To determine net ATP, existing water payments must be subtracted from the estimate of total ATP in the study area. This assumes that these existing payments would continue after the alternative is implemented. If none, or only a portion of existing water payments would persist after the alternative, then those remaining costs should be subtracted from total ATP to derive net ATP. Net ATP reflects the remaining financial resources available for households to finance the alternative through annual water payments. If additional financial resources are available to fund the alternative, such as tax revenues, capital reserve funds, grants, or revenues from commercial and industrial water users, these resources can be added to the estimate of household ATP for municipal water services.

3.0 Methodology Performance

To evaluate how this methodology performs, this section compares estimates of ATP with existing water payments for the 1,831 communities for which water payment data is available. This highlights the maximum amount that households are expected to pay for municipal water services relative to what they currently pay. This is then compared with the EPA benchmark of 2.5% median household income. Table 3.1 shows the average and median annual water payment across the 1,831 communities and the estimated ATP relative to existing water payments using the "Reclamation approach" and using the EPA 2.5% benchmark.

Table 3.1 – Comparing Estimates of Ability to Pay with Existing Water Payments

Statistic	Existing Annual Water Payment	Reclamation ATP vs. Existing Payment	EPA 2.5% Benchmark vs. Existing Payment
Average	$575	+52%	+214%
Median	$518	+29%	+168%

Values are 2020$. This reflects 1,831 communities across the 17 western states.

As shown, the EPA 2.5% benchmark provides a relatively high estimate of ATP, suggesting that communities could on average afford water payments increasing by 214%, with half the communities able to afford a 168% increase or more. Such large increases have the potential to reduce spending on other necessities and negatively impact household wellbeing. The approach presented here suggests that communities could on average afford water payments increasing by 52%, with around half the communities able to increase water payments by 29% or more. This is deemed a more reasonable increase for households to afford without imposing financial hardship. Some households may be able to afford more than this, but keep in mind that these estimates are applied at the community level. Under the EPA benchmark, all communities with an average water payment below 2.5% median household income are assumed to be able to pay more than they are currently paying for water, which is about 96% of communities in the dataset. Under the Reclamation approach, around 61% of communities are estimated to be able to afford higher water payments, while the remaining 39% are already paying at or above their ATP.

4.0 Ability to Pay Estimation Tool

While household ATP can be estimated for an area of interest by utilizing the data and methods presented in this document, a "Household Ability to Pay Estimation Tool" is also provided to make the process quick and easy, while also ensuring the calculations are properly conducted. The tool is also a good way for an analyst to check their calculations and final estimate. This section provides an overview of the estimation tool, which is simply an excel spreadsheet that carries out the steps and calculations presented in this document using key input data entered by the user. The estimation tool will be maintained by the TSC Economic Analysis Group and updated in the future as more data becomes available and model updates are made.

To use the estimation tool, the user is required to gather the household and community level data for their study area shown in Table 4.1. The table indicates the suggested data source and what the information is used for in the estimation process. As shown, the user only needs to gather data from the ACS and Sperling's Best Places for their area of interest. The remaining inputs are user specified. The estimation tool provides an estimate of ATP per household per year for the study area. The user can then specify the number of households affected to get an estimate of total ATP, and the existing monthly water payment for households can be entered to get an estimate of net ATP. Note that this amount should reflect the existing water payments that are expected to persist with the alternative in place, which may be less than the existing payments if the alternative reduces or replaces any existing water expenses. The tool provides outputs in the same dollar year as the input data. This means that price-level adjustments should be made for the desired output year before entering values into the tool.

Table 4.1 – Input Data for the Household Ability to Pay Estimation Tool

Input Data	Data Source	Use
Median Household Income ($)	ACS 5-Year Estimate	Regression Model
Average Household Size	ACS 5-Year Estimate	Regression Model
Home Ownership (%)	ACS 5-Year Estimate	Regression Model
Total Population	ACS 5-Year Estimate	Regression Model
Poverty Rate (%)	ACS 5-Year Estimate	Adjust ATP Threshold
Cost of Living Index (base=100)	Sperling's Best Places	Adjust Necessary Expenditures
State	User Specified	Determine ATP Threshold
Households Affected (Service Area)	User Specified	Calculate Total ATP
Existing Monthly Water Payment	User Specified	Calculate Net ATP

5.0 Conclusion

This document provides a methodology for estimating household ATP for municipal water services for any community in the 17 western states using readily available data for the area of interest. An estimation tool is also provided to allow an analyst to quickly employ this methodology and estimate ATP for their area of interest. It is important to note that this amount reflects only the resources available from households to finance the project through water payments. If financing is available from other sources, such as capital reserve funds or commercial and industrial water users, this can be added to the estimate for household ATP. That said, methods for estimating commercial and industrial ATP have not been developed to the same extent as irrigation ATP and household ATP. The methodology is theoretically similar, but data availability is limited for application.

For early M&I ATP studies done by Reclamation, the EPA 2.5% of median household income benchmark served as the starting point, but several shortcomings have been identified over the years. In particular, this approach (1) evaluates gross household income, rather than focusing on discretionary income; (2) ignores differences in cost of living, which affects discretionary income; (3) does not account for poverty or low-income households, although affordability affects these households most; and (4) the use of 2.5% is arbitrary and not based on observed household behavior or actual water payments. The approach presented here addresses these shortcomings to provide a more accurate, consistent, and defensible estimate of ATP, while the EPA 2.5% benchmark is found to provide a relatively high estimate of ATP with the potential to impose financial hardship on households.

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