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One Water demand management: rethinking ratemaking

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Boston University Institute for Sustainable Energy

One Water Demand Management Rethinking Ratemaking

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INTRODUCTION

Many cities in the United States are experiencing population growth, causing water demand to grow and straining existing water supplies and infrastructure. Meeting an ever-growing demand for water with the purchases of additional supplies and the development of more infrastructure is not economically or environmentally sustainableⁱ. This is one of the factors driving water utility managers, urban planners, and municipal leaders in much of the United States to rethink the way we manage water.

One approach to water management that is being embraced is integrated water management, also referred to as One Water. One Water is defined by the Water Research Foundation (WRF) as “an integrated planning and implementation approach to managing finite water resources for long-term resilience and reliability, meeting both community and ecosystem needs.”ⁱⁱ It takes a holistic view of all forms of water – including potable, wastewater, stormwater – and encourages all stakeholders to identify common goals and mutually beneficial solutions. These may include various approaches to water reuse and how green infrastructure can provide benefits in stormwater management and in community engagement also, for example.

The way the One Water approach is discussed and implemented generally emphasizes alternative ways to meet a community’s demand for water to the conventional approach of identifying new sources and treatment infrastructure as needed. However, there is no reason that demand management should not be part of an overall One Water approach also.

This paper focuses on opportunities for utility rate structures to support the One Water approach. As many city populations increase, utilities may need to expand sources and treatment infrastructure and, as a result, be required to increase their revenues. Yet in developing a new rate structure, certain measures can be taken to encourage future demand management, limiting the need for yet more expansion of sources and treatment infrastructure further into the future. This is consistent with the One Water principle of ensuring long-term resilience and reliability, and considering both the community and the ecosystem. In any approach to water management and to rates in particular, consideration of equity for low income customers is critical. This topic is also part of the focus of the new rate structure presented in this paper.

The paper describes broad considerations and principles that can help water utilities seeking to assess the interplay between ratemaking, water demand, and water conservation. It also presents a specific case of a new rate structure for New Braunfels Utilities (NBU) in Texas, who was a partner for some of this work and who found themselves seeking to simultaneously increase revenue, encourage water demand management, and maintain equity.

1. RATEMAKING CONSIDERATIONS

1.1 Rising Water Costs

In the United States, water and wastewater costs have risen at a rapid rate in the last decade especially, exceeding inflation, fuels, electric/gas utilities, and even household income. As seen in Figure 1 below, water and sewer costs have grown at an average annual rate of 4.8% since 1986ⁱⁱⁱ.

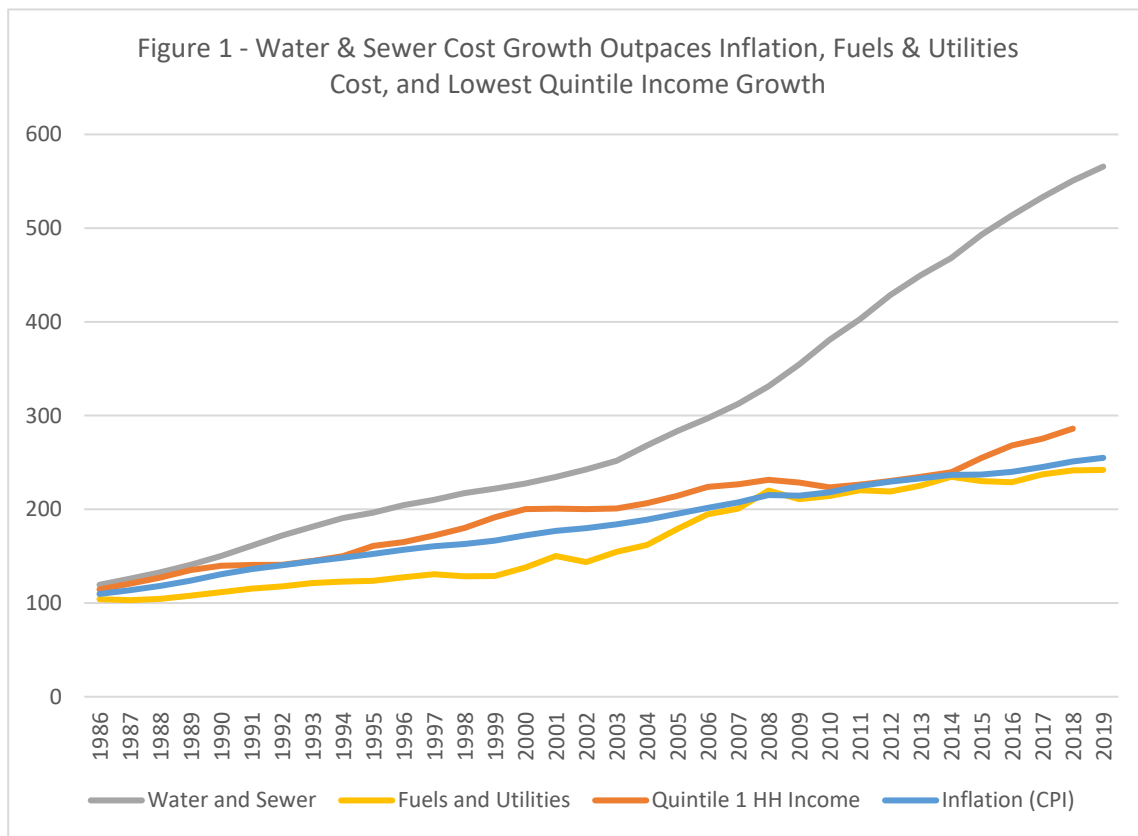


Figure 1 uses CPI data taken from the Bureau of Labor Statistics to illustrate inflation for the average yearly costs of Water & Sewer, Fuel & Utilities, the first quintile of household income, and inflation.

One driver of increasing water costs is an increasing need to replace aging infrastructure. This need is exacerbated by extreme weather events, which increase supply variability and accelerate the depreciation of aging infrastructure. As utilities consider changes in rates to cover additional costs of supplies and infrastructure, it is important to consider how to maintain or improve affordability and opportunities to use rate structures to increase water conservation, while also ensuring that the utility maintains revenue stability.

1.2 Urban Population Growth

Texas is home to some of the cities that regularly rank among the fastest growing (by population) in the US. Figure 2 illustrates the growth of customer bases of utilities in Texas, as well as the average cost of a monthly residential water bill^{iv}:

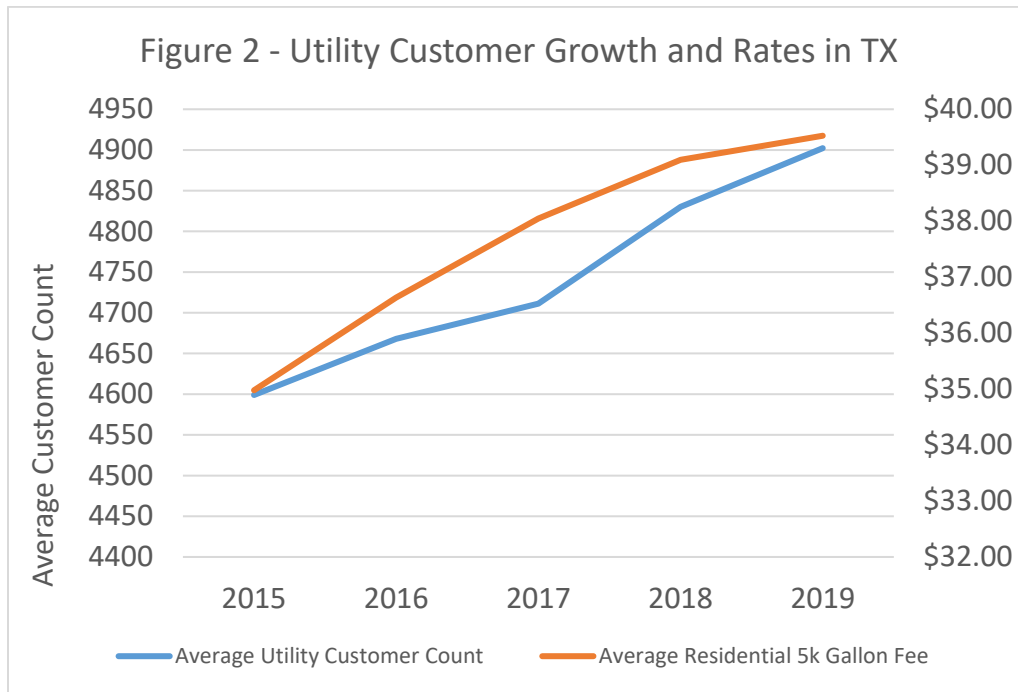


Figure 2 shows both the average customer count (in blue) and the average cost of a monthly residential water bill for 5,000 gallons (in orange) from the years 2015 – 2019.

In cities that are experiencing rapid population growth, the increase in demand may drive investment in additional infrastructure and the purchase of water supplies that have higher marginal costs. In turn, the utility must increase its overall revenue requirement to afford these purchases. Raising rates for all customers is a simple solution, but it is not always the equitable one. Utilities can consider models that raise rates by equitably distributing its costs across its customer base as well as promoting conservation.

1.3 Revenue

A typical water utility's revenue is composed of two key components: variable and fixed. Utilities generate variable revenue based on customers' water usage. The variable rate charged to each customer usually depends upon the type of usage and which customer class they belong to – typically a utility will have four main classes:

- 1) Residential/Single Family
- 2) Multi-Unit/Multi-Family
- 3) Commercial/Industrial
- 4) Irrigation

The variable rate might also depend upon the amount of usage. A utility may use an increasing block structure, a flat rate structure, a decreasing block structure, or a combination of these structures across multiple customer classes. In the case of an increasing block structure, as a customer's usage increases above a certain level of consumption, the unit price increases. A utility can have multiple tiers (blocks) of increasing unit prices as consumption increases.

Previous studies have shown that increasing block rate structures that have three or more blocks help to promote conservation^v. While many studies conclude that the price elasticity of water is typically low, a 2007 study from Olmstead, Hanemann and Stavins demonstrated that increasing-block rate structures may result in higher price elasticity and lower demand by customers^{vi}. An empirical study from the Environmental Finance Center that is based on Texas utilities also found that an increasing block structure for water rates is critical for effectively encouraging conservation^{vii}.

The second component of revenue for a water utility is fixed, and is set in a variety of ways depending upon the utility. Typically, fixed revenue is collected through a monthly customer service charge that varies with the size of the customer's meter.

For customers living in multi-unit complexes, the equivalent of a customer service charge is a monthly unit charge, since domestic water usage for a multi-unit complex typically runs through a single meter. Specifically, while the owner of the complex will receive a single customer service charge for the meter, each unit will receive a monthly charge. This ensures greater equity amongst customers by more closely aligning residential and multi-unit water bills while also creating a reliable revenue stream for the utility that is not subject to the variability of monthly water usage.

The more a utility can align their fixed and variable costs with fixed and variable revenue respectively, the more fiscal security the utility has. In recent years, some utilities in North America have seen a decline in annual water sales, in part due to greater efficiency in water use. If those utilities secure a greater proportion of revenue from fixed charges, revenue will become more stable and predictable^{viii}. Meanwhile as water utilities introduce a new rate structure, a common concern is revenue stability. If

customers respond to a price signal by reducing consumption, the utility may experience an unexpected revenue shortfall. Fixed revenue mitigates risk associated with the variability of water usage by customers. When changing their rate structure, a utility may benefit from increasing the percentage of their total revenue which comes from fixed charges. Fitch Ratings Inc. believes a key indicator of a strong financial profile for a water utility is that 30% or more of its revenue comes from fixed charges^{ix}.

When utilities need to meet increasing water demand, a common solution is to purchase the rights to additional water supplies. The literature suggests that in this scenario traditional water rate structures often struggle to recover long-run costs and that new innovations within rate structures are necessary to cover the long-run marginal cost of providing water^x. A ‘pass-thru’ rate, if allowed by the applicable regulatory body, can be implemented to ‘pass’ the costs of the additional water supply on to customers outside of the core rate structure. With a pass-thru rate, utilities have a robust addition to their revenue because actual supply costs charged to the utility must be trued up annually and the fee can be adjusted accordingly. This ensures greater financial stability for the utility by aligning rates with their costs. It also reflects the real costs and incorporates the sale of any water supplies by the utility as a credit against the fee.

There is concern that increasing block rate structures or peak pricing – both forms of pricing that are adopted to encourage conservation – can leave a utility dependent upon peak demand to meet its revenue requirements^{xi}. A utility cannot anticipate the degree to which customers will respond to conservation signals introduced within their rate structure. However, the inclusion of a pass-thru rate will help to mitigate potential revenue volatility associated with responses to conservation signals^{xii}.

Utilities must also be careful to avoid over-investment. Population growth might increase the rate base and call for new infrastructure and capacity, but this infrastructure and capacity must be procured ahead of the needs. If a utility engages in overly aggressive expansions at increasing incremental costs, it may place a financial burden upon itself and ratepayers if population growth isn’t as fast as expected while its investments are sunk. In this case, the utility might need to increase rates significantly to cover the revenue requirement or utilities might fall short. To avoid this, investments in infrastructure and capacity should be made with caution, and utilities should consider all options, including conservation, to arrive at an optimized supply solution.

1.4 Equity

It is also vital that all customers can afford the water required for basic daily needs and that those who consume a relatively small amount of water do not see a sudden, large increase in their bill when the rate structure is changed. However, there are concerns that underpriced water encourages unsustainable consumption^{xiii}. While it is a simple endeavor to raise rates to increase revenue, it is more challenging to raise rates without creating too many winners and losers. Ideally, the costs of the utility service should be distributed across the entire customer base such that each customer's usage reflects the utility's costs associated with serving them^{xiv}. However, the utility must also consider customers' ability to pay, and limit price increases for the lowest volume users to maintain affordability for low income customers.

1.5 Conservation

Utilities cannot continue to build new infrastructure and supply more water indefinitely as populations grow - this will create a spiral of increasing costs. Water supplies are finite and at some point cannot meet the needs of sustained water demand growth, and especially not at stable prices. Utilities need to rethink the way they build infrastructure and supply water, and the best place to start is conservation. By managing the demand of their customer base, a utility can help ensure the long-term availability of finite water supplies while deferring infrastructure and supply costs.

Naturally, the coupled issues of conservation, utility revenue, and affordability must be assessed carefully by utility managers before proposing a change in rates. In certain situations, an increase in rates may push customers to significantly reduce water usage, causing total utility revenue to decrease. However, reduction in overall revenue owing to reduced demand can be avoided through equitable, targeted rate increases and innovative rate structures. A recent study by Olmstead and Stavins found that a 10% increase in the marginal price of water is associated with a decline in residential water demand between 3% and 4%^{xv}. Using targeted rate increases within an increasing block structure can support effective demand management, even if overall elasticities are relatively low.

A first step to achieving conservation is to utilize increasing block structures with targeted, relevant consumption blocks. Many water utilities incorporate increasing block structures, but the usage cutoffs are often arbitrary. A utility can analyze their historical billing data and determine the water usage cutoffs that correspond to certain percentiles of users. This same data can also reveal the amount of water consumed by each percentile of users. With this information in hand, a utility can create an increasing block structure that has usage cutoffs which correspond to particular percentiles of users and set rates that are appropriate to their revenue requirements. Likewise, it can estimate the change in total usage according to an assumed demand elasticity for each customer class. The utility can then set the usage cutoffs and rates for each block to balance revenue, equity and conservation requirements.

Utilities can also implement peak pricing by putting a premium on their variable rate structure during times of peak demand. This can work to increase revenue while also shaving daily and monthly peaks in demand, which can mitigate the need for increased infrastructure capacity and the associated costs.

To the extent possible, it is also helpful to increase the percentage of total revenue that comes from fixed charges. A key utility objective is to meet its revenue requirements so that it can continue to supply water to its customer. As more of its revenue is generated through a relatively stable revenue stream, this creates greater opportunity to set rates in a manner that encourages conservation. Since conservation relies on a change in consumer behavior, clear communication of rate structures designed to encourage conservation by the utility to consumers is of critical importance^{xvi}.

1.6 Modelling

The Alliance for Water Efficiency's (AWE) Sales and Forecasting model provides a five-year forecast of water demand and revenue by using historical billing data, weather, and existing/new rate structures as inputs. This forecast is robust because it incorporates variability in water demand that can occur as a result of weather, droughts, and demand elasticities. Likewise, it can run upwards of 1000 simulations to anticipate risk surrounding the probability of meeting a particular revenue requirement during each year. This is known as a Monte Carlo simulation – it takes a random sample of inputs and reruns the simulation. In this case, a random sample of growth rates for accounts by customer class and historical weather data. The way that the model incorporates historical weather data is described below in AWE's model documentation:

“The model uses a simulation technique called indexed sequential simulation to evaluate the impact of weather on near-term demand. Given historical data on monthly precipitation and average maximum daily air temperature, the model randomly draws 5 year sequences of these data for use in each simulation trial. For example, if the model is given 30 years of precipitation and temperature data spanning the period 1980 to 2009, on the first trial it may randomly draw the weather sequence for 1993-1997. On the second trial it may draw the weather for 1982-1986. It will continue to randomly draw weather sequences until all the model trials have run. In cases where there is not a full 4 years of data following the first year in the sequence -- in the previous example this would be the case for any sequences starting after 2005 -- the model wraps around to the beginning of the weather data. Thus, in the previous example the sequence starting in 2006 would be {2006, 2007, 2008, 2009, 1980}, while a sequence starting in 2008 would be {2008, 2009, 1980, 1981, 1982}. This is called sequence recycling and it is common to this type of simulation. For each weather sequence, the model adjusts average water use for each rate class based on how much the sequence deviates from long-term normal weather.”^{xvii}

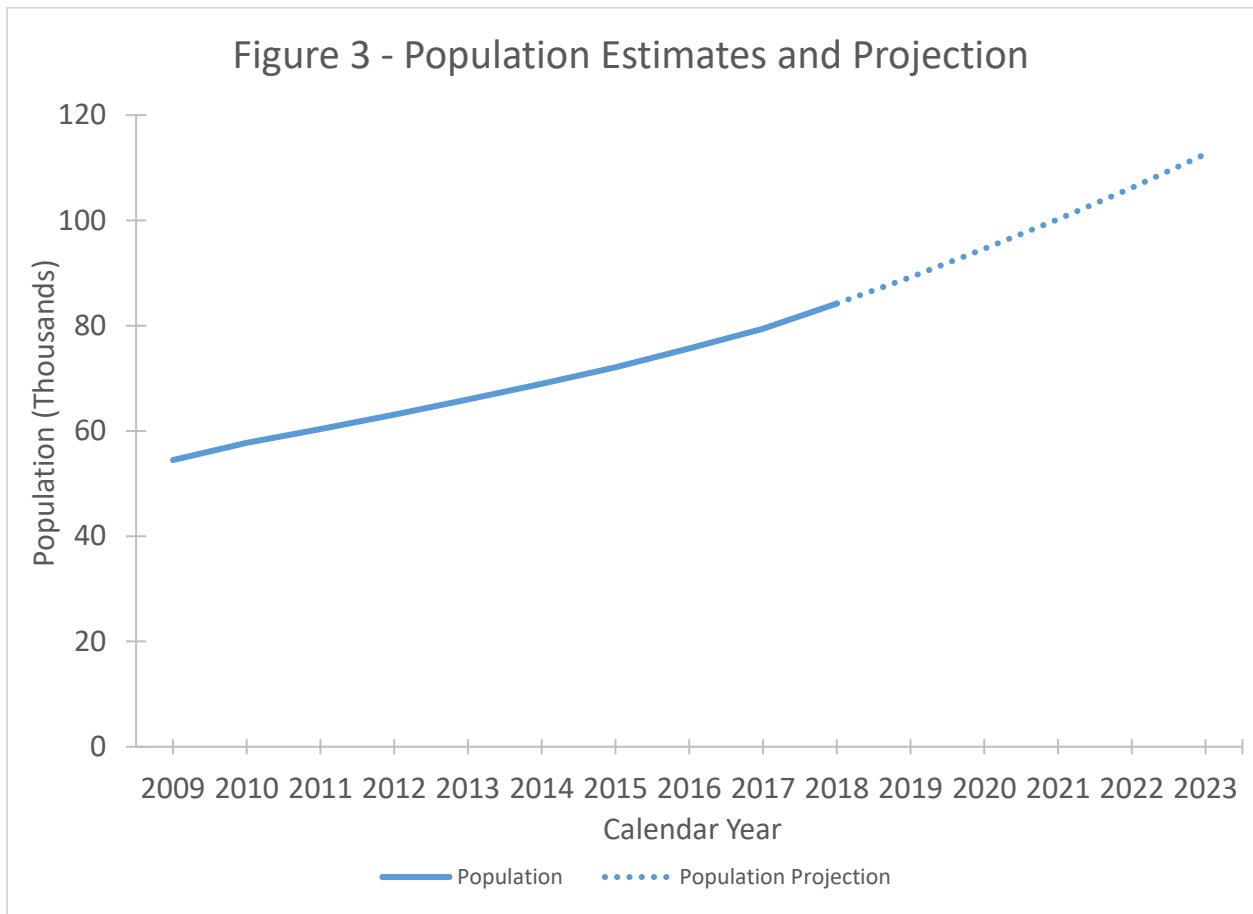
From a rate design perspective, this a relatively flexible model because it allows comparison of an existing rate structure to an entirely new rate structure. For example, it allows for uniform, variable,

block, and drought rates. This enables a utility to assess the estimated impact of changes in the rates themselves or an entirely new structure, in terms of sales volume and revenue. In turn, this provides the basis for utilities to make informed decisions about meeting revenue requirements and conservation. It also provides bill impacts in the model outputs for each customer class, allowing for the utility to understand the equity impacts of proposed rate changes.

2. BACKGROUND ON NEW BRAUNFELS

Boston University’s Institute for Sustainable Energy partnered with New Braunfels Utilities (NBU, a municipally owned, combined power and water utility), to identify actionable opportunities to promote sustainable management of both their water supplies and demand through a One Water framework. For NBU, a key challenge is determining how to sustainably manage their water supplies and demand in the context of sustained and rapid population growth.

New Braunfels is a city located in both Comal and Guadalupe counties in Texas and is situated in the northeastern portion of greater San Antonio. The population of New Braunfels was estimated be nearly 85,000 in 2019^{xviii}. According to a projection from Arcadis (see Figure 3 below), the population of New Braunfels is expected to steadily increase over the next few years. This presents a challenge to NBU since the population increase in urban service areas will increase water demand, require new water supplies, and strain existing infrastructure. Also importantly, NBU needs to ensure it has sufficient capacity to meet demand spikes during peak months and days.



xix

Figure 3 is a population projection completed by Arcadis and included in NBU’s Water Resources Plan (May 2018)

In its Water Resources Plan (May 2018)^{xx}, NBU observed that their firm yield water supplies during times of drought was reduced by up to 20% compared to the maximum capacity allowed by the current surface water treatment plant. The utility decided that sustained population growth rates near 6% per annum may make it difficult to meet water demand in the short term, especially in cases of drought. Consequently, NBU purchased additional water supplies and is substantially upgrading their infrastructure. The cost of these supply and capital infrastructure improvements resulted in an increase in revenue requirements that is substantially higher than normal. NBU set a revenue target of \$20,339,000 for FY 2020, as compared to a total revenue of \$15,668,000 in FY 2019 – a nearly 30% increase. Such a large increase requires careful analysis, especially when NBU is trying to promote water conservation.

In its new rate design process in 2019, NBU sought to achieve a sizeable revenue increase in a way that promotes conservation, without significantly impacting low usage customers. Given the intricate nature of NBU's prior rate structure and the need for substantial rate restructuring, the ISE team required a sophisticated model along with involved data processing that could provide a robust assessment of future revenue and volume. The BU ISE team chose to use an advanced ratemaking model from the Alliance for Water Efficiency, described in section 1. This model considers historical water usage, account growth rates, temperature and rainfall. Using the inputs, the model performs up to 1000 Monte Carlo simulations to estimate the effects of rates on revenue and sales volume for billing scenarios with both variable and fixed charges, increasing block structures, and peak and off-peak pricing. Likewise, the model factors in demand elasticities and provides multiple tools to adjust rates across classes and meter sizes. The model also evaluates the affordability of water bills and analyzes bill impacts.

Leveraging Prior Knowledge

The ISE team considered prior analysis of NBU's pumping and billing data in order to effectively redesign their rate structure. It was important that the new structure integrates itself with NBU's goals that are a part of a broader One Water framework. For NBU, these goals include water conservation, equitable rates, alignment of inside and outside city limit rates, and mitigation of the impact of urban densification on water supply & demand.

The ISE team previously analyzed historical water demand data by customer class (Residential, Irrigation, Multi-Unit, Commercial, etc.)^{xxi}. This revealed two important pieces of information:

- 1) Water demand and growth is highly variable across customer classes.
- 2) Water demand is extremely skewed – a large percentage of overall demand comes from a relatively small percentage of users.

By understanding the composition of NBU's water demand, the ISE team suggested rate changes to increase revenue with minimal impact on low usage customers. This is accomplished by imposing the greatest rate increases on the highest consumption blocks and for the customer classes which make up larger portions of overall demand - keeping rates for low usage customers relatively low to ensure

affordability. In this scenario, top users are likely to reduce their demand (thus achieving conservation) while still paying more overall, and so helping to achieve the required rate increase to fund the expansion of water supplies. With the additional revenue generated by top users, NBU could afford to reduce outside city limits rates and align them with inside city limit rates. This simplifies their billing structure and promotes greater equity amongst ratepayers.

While large rate increases for the highest consumption blocks are projected to increase revenue, they did not meet NBU's target revenue increase. Therefore the ISE team implemented peak pricing during the four months of the year in which NBU historically exhibited the largest demand (June, July, August, and September). During peak months, there is a rate increase in addition to the newly proposed rates. This will allow NBU to capture a significant revenue increase while also encouraging customers to reduce their water usage during peak months. This is crucial because it will:

1. Capture greater revenue
2. Reduce the need for new supplies and associated costs.
3. Reduce the actual depreciation of existing infrastructure and associated maintenance costs.

Note that the rate changes that were implemented for NBU were made specifically in response to an analysis of their billing data; this is not a one-size fits all solution. Rate structures should be based upon historical billing data and region-specific factors^{xxii}. Peak pricing and increased block structures are powerful tools that a utility can use to promote conservation and raise revenue, but how they are implemented should be based on the particular utility's demand distribution.

3. A NEW RATE STRUCTURE FOR NEW BRAUNFELS

3.1 Drivers of the new rate structure

In response to sustained population growth, NBU evaluated supply expansion options in its Water Resources Plan and signed contracts to increase their total supply by over 30% within the next 5 years, at higher prices than existing water supplies. As a result of these costs, NBU required revenue to increase from \$15,668,000 in FY 2019 to \$20,339,000 in FY 2020. The question then became: how can NBU meet this revenue increase while also promoting water conservation and maintaining affordability?

In order to mitigate the impact of sustained population growth on overall water demand and supply needs, NBU defined a long-term strategy to avoid further supply expansions by setting a conservation target of 120 gallons per capita per day (GPCD) by 2042 (as compared to their current level of 141 GPCD). In their pursuit of this goal, NBU implemented an increasing block rate schedule for water, provided online, educational materials for water conservation, and offered rebates for water conserving technologies.

In addition to pursuing these conventional conservation strategies, NBU will seek additional strategies to reduce water demand further to 120 GPCD by 2042. The ISE's analysis^{xxiii} of NBU's pumping and billing data indicated:

1. Growth in water demand is not consistent (from year to year) and does not grow proportionally with population – consistent with national trends that show declining GPCD.
2. The fastest growing segments (customer classes) driving increased water demand aren't necessarily the ideal targets for water conservation.
3. Water conservation efforts that target top users and developers could prove particularly effective and have potential to reduce per capita water demand to the 120 GPCD target, potentially earlier than 2042.

Given the current range of approaches NBU uses to address water demand, ISE sought to use the pricing of water as an additional approach to support demand management^{xxiv}. Using the above insights in conjunction with the model, the ISE team designed a rate structure for NBU that is projected to meet the revenue requirement for FY 2020 that reduces peak demand and ensures equitable pricing for customers. This rate structure will defer future water infrastructure requirements through reduced demand, resulting in future savings for ratepayers, strengthening the financial health

of NBU, and opening the possibility for alternative water supply expansion in the One Water framework.

According to ISE's estimates, the new rate structure for NBU should generate roughly 34% of their revenue from fixed charges in FY 2020.

3.2 Achieving a 30% revenue increase

NBU has a total revenue target of \$20,339,000 during fiscal year (FY) 2020 from August 1st 2019 – July 31st 2020, based on a new rate structure that went into effect on November 1st, 2019. The increase over the FY 2019 revenue target is a consequence of the increased marginal cost of expanding water supplies. Revenue in FY 2018 was \$15,567,000 and revenue in FY 2019 was \$15,667,656.

In order to help meet the revenue target, NBU proposed a water supply fee that will pass the cost of these supplies onto customers. It will be implemented as \$0.33 per thousand gallons water supply fee that is included within every rate for each consumption block for all customer classes. The ISE team simplified the overall rate structure by aligning rates outside city limits with those inside city limit rates. From there, the multi-unit customer classes were collapsed from a total of 11 rate classes to 1 rate class, ensuring that the cost of water was more equitable across all multi-unit customers. Previously, customers living in larger multi-unit complexes were paying arbitrarily more (per thousand gallons) simply because there are more units in their building. This is a natural consequence of multi-unit complexes that are close to the cutoff being charged at higher block rates.

The multi-unit rate structure was also adjusted so that it is better aligned with the residential customer class. A residential water bill is composed of a customer service charge and a variable rate charge for water consumed. For multi-unit customers, the bill has a similar structure except the customer service charge is called the monthly unit charge. There is also a customer service charge that varies with meter size but this is only charged once for the entire complex. In the new rate structure, monthly unit charges were raised appropriately to ensure residential customers did not receive relatively large bills for similar consumption profiles. While this does not work to encourage conservation in the same manner as an increasing block rate structure, it greatly simplifies a previously complex multi-unit rate structure and better aligns residential and multi-unit billing. Likewise, the effectiveness of an increasing block rate structure for multi-unit customers is difficult to assess. This is because water usage for a multi-unit complex is typically measured through a single meter per building, so water usage per unit is unknown – this is why the cost of water is often incorporated into a tenant's monthly rent. Consequently, an increasing block structure would increase the total bill for a particular multi-unit building and the landlord/owner of the building would raise monthly rents for all individuals living in the building, but the individual tenants who consume water would not see an incentive for conservation.

In redesigning the NBU’s rate structure, the ISE team made use of an important piece of knowledge about the distribution of NBU’s overall water demand: a relatively small number of users represent a significant proportion of overall demand. We also knew that water conservation was an important goal for NBU; therefore, we sought to promote water conservation while increasing revenue by implementing the greatest rate increases on the higher consumption blocks and raising lower consumption blocks by less. Imposing the largest rate increases on the few yet large users of water helped to ensure small meter and low usage customers were not severely impacted, supporting affordability, and limiting rate increases for a large number of customers.

Table 1 provides a summary of the rate changes implemented.

Rate Class	Change in Off Peak Rates	Change in Peak Rates
Residential Inside City Limits	16.86%	36.41%
Residential Outside City Limits	6.24%	32.01%
Irrigation Inside City Limits	21.75%	52.18%
Irrigation Outside City Limits	10.68%	38.35%
Multi-Unit Inside City Limits	-7.27%	13.67%
Multi-Unit Outside City Limits	-11.61%	1.84%
General Service Inside City Limits	26.33%	58.16%
General Service Outside City Limits	14.86%	43.80%

Table 1: Summary of Variable Rate Changes (\$ per thousand gallons consumed), showing percentage change in off peak and peak rates for each customer class. Peak rates are applied from June 1st to September 30th annually. Percentages are calculated as a straight line average for all consumption blocks within the specified customer class.

The percentages listed are straight line averages of the percentage change in the rates (dollars per thousand gallons consumed) for every consumption block within that particular customer class. The percentage changes listed for peak rates are calculated in the same way as off peak rates, except it is the percent difference between the peak rate and the rate for that class from the previous rate structure. These rates go into effect during the four months with greatest average historical demand (June 1st – September 30th).

As seen in Table 1, the off-peak rate increases are smallest for residential customers outside the city limits and largest for commercial customers (General Service) inside the city limits, while off peak rates actually decrease for multi-unit customers. Although we aligned inside and outside city limits rates, the percentage change is always higher for inside city limits because outside city limit rates were always higher within each class in the previous rate structure. Multi-unit rates are indicated as declining because the percentage is calculated as a simple average of the percentage change for all multi-unit classes, for which there was a total of 11 classes.

Previously, rates were arbitrarily higher for customers living in larger multi-unit complexes. Therefore when the off peak rate for all multi-unit customers was changed to \$2.50 per thousand gallons, a majority of the prior rates exceeded that price. The percentage changes listed in this table are not representative of how bills will change for each customer class on average, but rather the average change in the rates themselves.

Table 2 provides a summary of the estimated annual revenue changes.

Rate Class	Change in Total Annual Revenue	Change in Annual Fixed Revenue (Service + Unit Charges)	Change in Annual Variable Revenue
Residential Inside City Limits	12.66%	0.79%	24.65%
Residential Outside City Limits	10.43%	-8.08%	20.84%
Irrigation Inside City Limits	46.63%	100.00%	37.48%
Irrigation Outside City Limits	32.91%	81.92%	26.17%
General Service Inside City Limits	41.43%	25.12%	45.63%
General Service Outside City Limits	24.42%	4.86%	30.99%
Multi-Unit Inside City Limits	45.39%	56.13%	45.63%
Multi-Unit Outside City Limits	24.90%	45.86%	30.99%
Total All Rate Classes	26.45%	16.48%	32.43%

Table 2 – Summary of Revenue Changes

The percentages listed in Table 2 represent the increase in revenue that will occur within each customer class under the new rate structure, as compared to the old rate structure, based on the AWE model projections and accounting for the number of customers in each class as well as the projected range of usage by different customers within each customer class. The total overall revenue increase is slightly less than the 30% revenue increase target because the rate increase did not come into effect until November 2019. Consequently, the ISE team took a weighted average of the revenue from the old and new rate structure following the proportions of historical average revenue collected from each period (29% from August 1st through October 31st and 71% from November 1st through July 31st). A significantly larger percentage of the revenue increase is expected to come from variable revenue, as compared to fixed revenue.

Just as the average rate increase is consistently greater within each customer class for inside city limits, so are the estimated revenue increases.. The total revenue column consists of fixed charges and variable charges. The percentage change for residential customers inside city limits is negligible because one of NBU’s goals for ratemaking was to align inside and outside city limit rates.

Consequently, customer service charges for residential customers inside city limits rose slightly, while the service charge for residential customers outside city limits was lowered to create alignment.

Fixed revenue for multi-unit customers rose sharply in order to better align the cost of water for multi-unit customers with residential customers. Irrigation exhibits the largest revenue increase because previously NBU's fixed charge for irrigation was considerably lower than the fixed charges for other customer classes. More importantly, significant rate increases on other customer classes, e.g., residential and commercial customers, would be a notable burden on the everyday use of water for a large number of customers. Irrigation is typically not imperative and may be associated with excessive use of water, so a large rate increase for irrigation imposes less of a burden given the potential for behavior change. The large rate increases for irrigation customers are projected to help to accomplish water conservation.

Part of the revenue increase is driven by the implementation of peak pricing for NBU during the four months of their greatest usage – from June 1st to September 30th. Peak pricing could also prove useful for utilities that have not installed separate meters for indoor and outdoor usage – especially if seasonal peaks are driven by irrigation. Without the ability to differentiate indoor, baseline usage from seasonal irrigation peaks, a utility cannot introduce differential pricing for different end-uses of water. But, as is the case for NBU, if the utility has strong reason to believe irrigation is driving seasonal peaks, price signals can be used to encourage customers to limit summer usage to keep it closer to winter “base level” use.

We emphasize that utilities should carefully consider their demand data to see if the monthly peaks are significant and understand the source of the peaks. Otherwise, peak pricing may prove ineffective and potentially disrupt the affordability of “base level” (indoor) water needs for customers. The introduction of peak pricing will increase revenue in a manner that recovers more of a utility's infrastructure costs through the customers which contribute the most to peak demand, which dictates capacity requirements for infrastructure^{xxv}.

4. MODEL PROJECTIONS FROM 2020-2023

In order to project revenue, the total volume of water sold for a utility must first be projected. This can be done using historical billing data from a utility and counting the number of bills by customer class, meter size, and the rate block. Likewise, the total volume of water sold should be summed by customer class and rate block^{xxvi}. Then, historical growth rates for each customer class can be used to project the total volume of water sold in future years. However, historical data should be considered closely if certain years involved extreme economic conditions, droughts, or sales that were specific to and only exist for a particular year^{xxvii}.

Another important consideration is the price elasticity of water demand. It is generally believed that water demand is price inelastic^{xxviii}. However, some specific end-uses of water can be somewhat elastic, for example outdoor irrigation and some commercial usage. This is consistent with studies that have shown water usage tends to be more elastic during peak months in regions where seasonal peak demand is largely driven by irrigation^{xxix}. How customers react to price changes is difficult to anticipate and can impact the accuracy of sales volume and revenue. It also may take time for customers to adjust their consumption according to rate changes, which can impact the ‘perceived’ price elasticity of demand. This depends on how thorough communication efforts were regarding changes in water rates^{xxx}. So, while pricing can be used to encourage conservation, it can be difficult to accurately forecast the reduction in usage.

The AWE Sales and Forecasting model does not allow for elasticities to vary by month, but does allow definition of different peak and off peak elasticity values, and they suggest a range of elasticities for the four, major customer classes - Single Family/Residential, Multi Family/Multi Unit, Commercial/Industrial, and Landscape/Irrigation. This study used the median value of those elasticities.

4.1 Conservation

Volume

The AWE model includes a five year forecast for sales volume and revenue, which is included in a plot below. In fiscal year 2018, NBU delivered a total of 3.98 billion gallons. The AWE model projects total sales volume to exceed 4.3 billion gallons by FY 2021 and 4.9 billion by FY 2023, under the newly proposed rates. If rates were left unchanged, the model predicts consistent growth during the next 5 years. However, the confidence intervals for both rate structures are relatively large and anywhere from a bit less than 1 billion gallons to nearly 2 billion gallons. How demand actually grows will depend upon

1. The true population increase,
2. Whether future real estate development incorporates aggressive water efficiency,
3. How the water rate structure changes in future years,
4. The effectiveness of future and ongoing water conservation efforts,
5. Whether Texas experiences an intense drought,
6. Infrastructure changes which impact water losses during distribution.

This indicates some of the factors which may impact future demand that are not captured in the baseline projection, but which contribute to the width of the confidence interval.

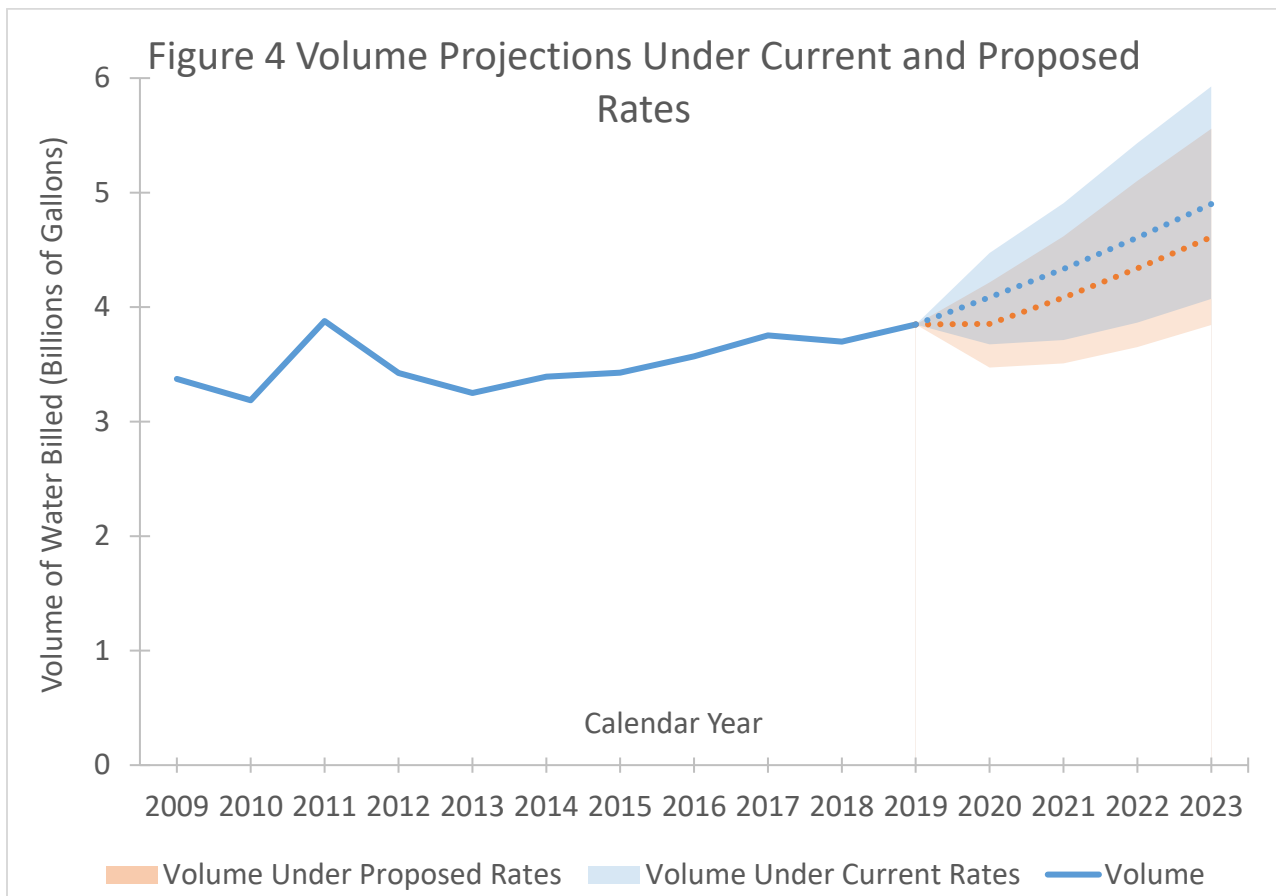


Figure 4 illustrates the historical total volume of water billed (in billions of gallons) in dark blue for NBU each calendar year from 2008-2019. After this point, volume is projected under both proposed rate (shown as the light blue dotted line, which came into effect as of November 2019) and the current rate structure (which is now the previous rate structure, shown as the orange dotted line). The shaded light blue area represents the confidence band for the total volume of water that would be billed under the current (previous) rate structure from 2020-2023 and the shaded orange area represents the confidence band for the total volume of water that would be billed under the proposed (now current) rate structure from 2020-2023. The shaded gray area is simply the colors of each confidence band overlapping.

GPCD

A projection of GPCD over time was constructed using the New Braunfels population projection from Arcadis that NBU incorporated into their Water Resource Plan^{xxxii}, and the demand projection from the AWE model. In the most optimistic case, there is potential for GPCD to fall below NBU's target of 120 GPCD as early as 2021 (as seen in Figure 5), which is far ahead of the 2042 date in NBU's target. However, the projected mean shows decreasing GPCD that does not fall below 120 GPCD before 2023. The new rate structure, while encouraging demand conservation, is not enough to reduce GPCD rapidly, and this approach should be built upon with customer outreach and education, rebates on water saving technologies, and future refinement of rates^{xxxiii}.

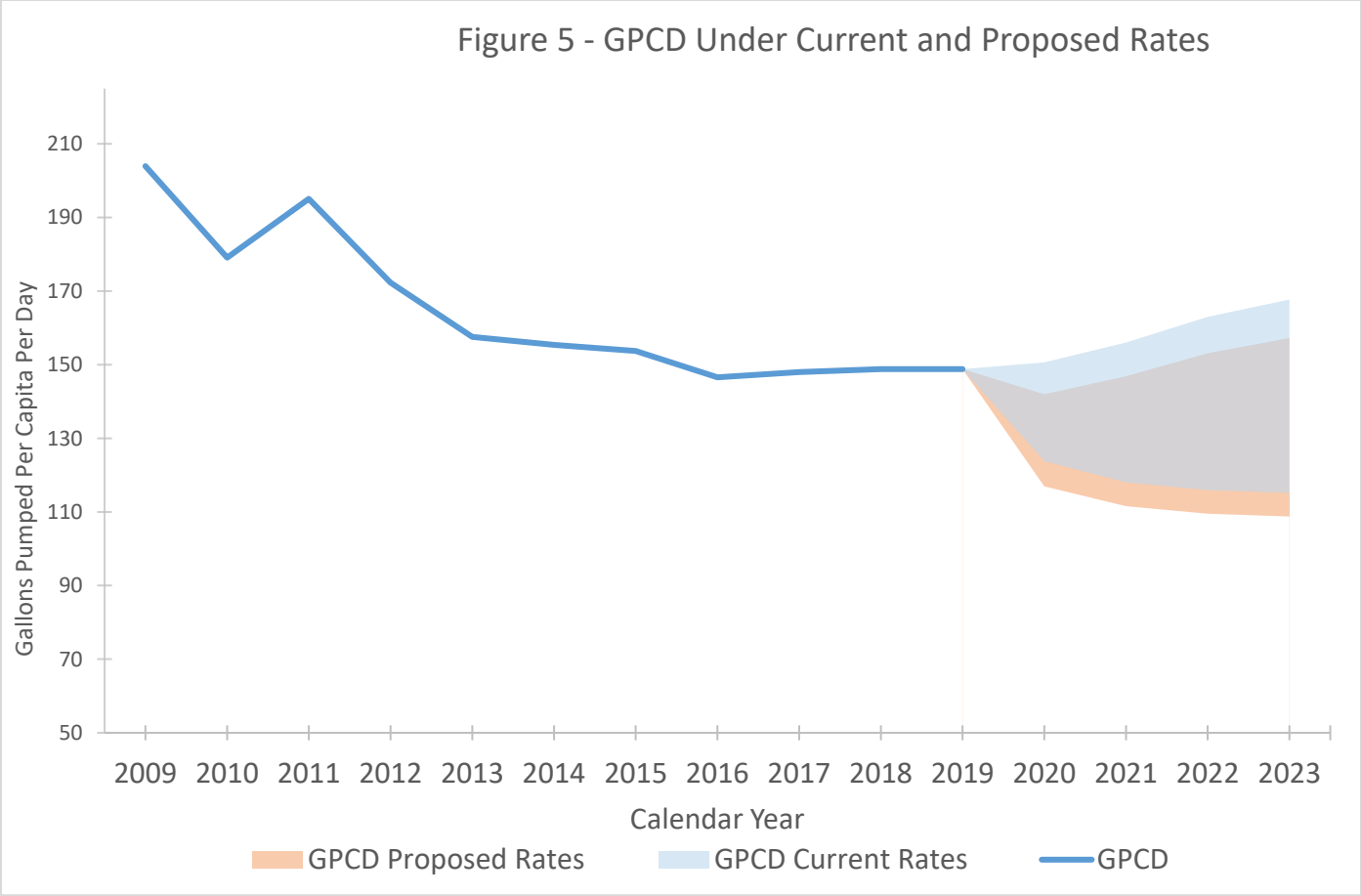
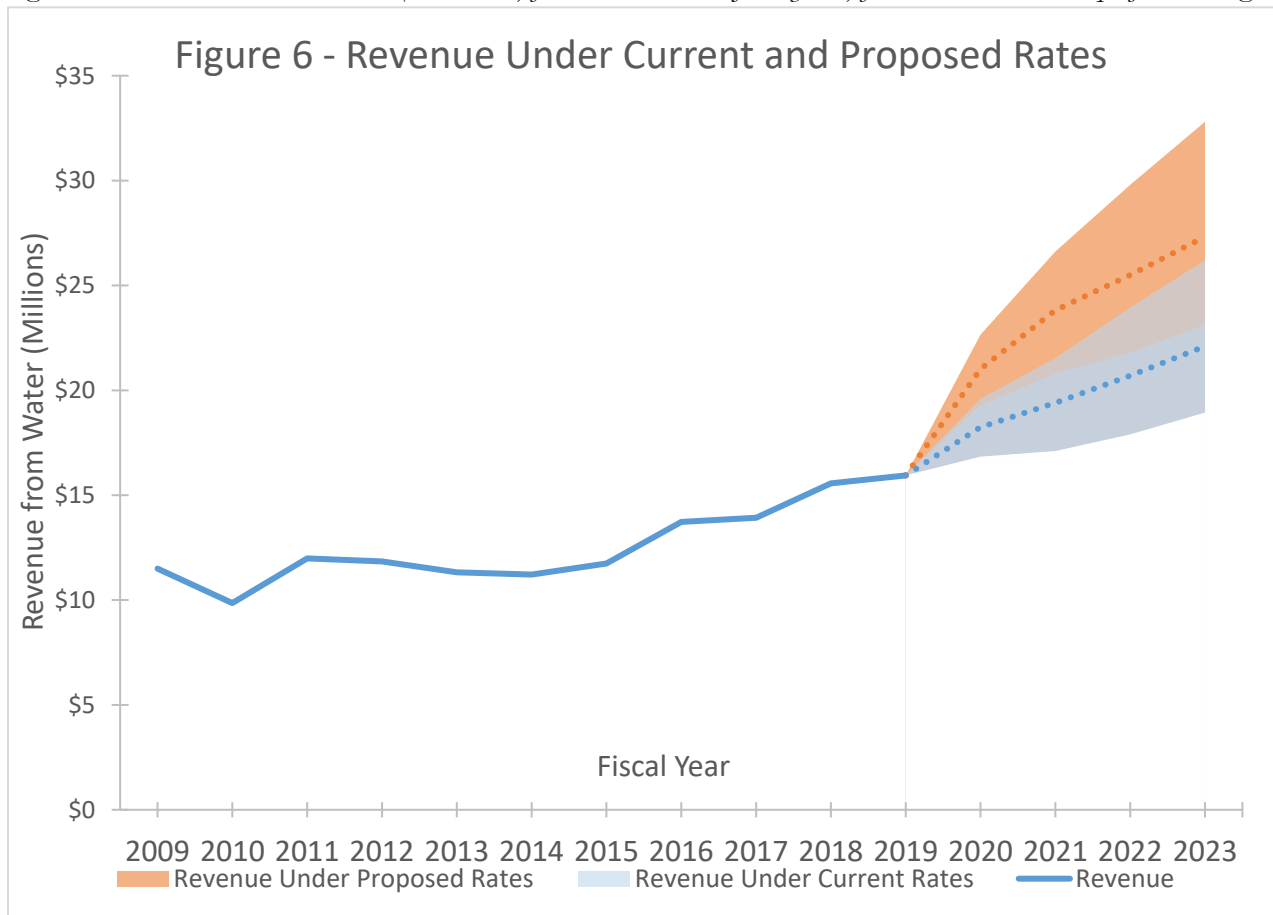


Figure 5 shows historical Gallons Per Capita per Day for New Braunfels Utilities from 2009-2019 and then includes a projection and confidence band under the new rate structure (GPCD Proposed Rates in orange) and the old rate structure (GPCD Proposed Rates in light blue). The shaded gray area is simply the colors of each confidence band overlapping.

4.2 Revenue

The AWE model projects that the new rate structure will yield a total revenue of approximately \$21,000,000 for FY 2020. This accounts for the fact that the new rate structure will not come into effect until November 1st, 2019, and also that the unit charge for commercial and multi-unit customers will not change until November 1st, 2019. On average, the AWE model projects average annual revenue to grow 14.42% each year during FY 2020-2023 as demand for water grows. As seen in Figure 1.6, the AWE model projects total revenue of approximately \$23,000,000 in 2021 and \$27,000,000 in 2023. However, there is still clearly a great degree of variability in these projections. Ideally, a utility should structure their rates such that the projected minimum is as close as possible to their revenue requirement. The new rate structure that NBU adopted based on this study is projected to generate a minimum revenue of \$19,300,000 in FY 2020 and an expected revenue of \$21,000,000. (Note that many other established methods do not incorporate statistics reflecting risk and probability.)

Figure 6 illustrates historical revenue (in millions) from 2008-2019 (fiscal years) for NBU. Revenue is projected using



a confidence band from FY 2020-2023 under the proposed rate structure (orange, now current) and the current rate structure (light blue, now previous). The blue/orange shaded area is simply an overlap of the colors.

4.3 Equity

Residential Bill Impacts

After proposing significant changes to NBU's rate structure, the ISE team analyzed the distribution of bill impacts to ensure unintentional impacts did not arise. It is important that low-usage customers face minimal bill impacts and that significant bill increases are limited to the highest percentile customers. This ensures a majority of users have affordable water while also promoting conservation.

Figure 7 plots the usage percentile for residential customers on the x-axis and the average percent change in a bill for a given consumption percentile. The roughly bottom 90% of residential customers should experience a bill increase of less than 15% while only the top 10% of residential customers should see their bill increase more than 15% (the large spike in Figure 1.7). For context, prior analysis by the ISE team^{xxxiii} revealed that the top 1% of NBU's customers contribute roughly 27% of their total water demand. This distribution of bill impacts works to equitably distribute costs according to a customer's usage by mirroring NBU's water demand distribution.

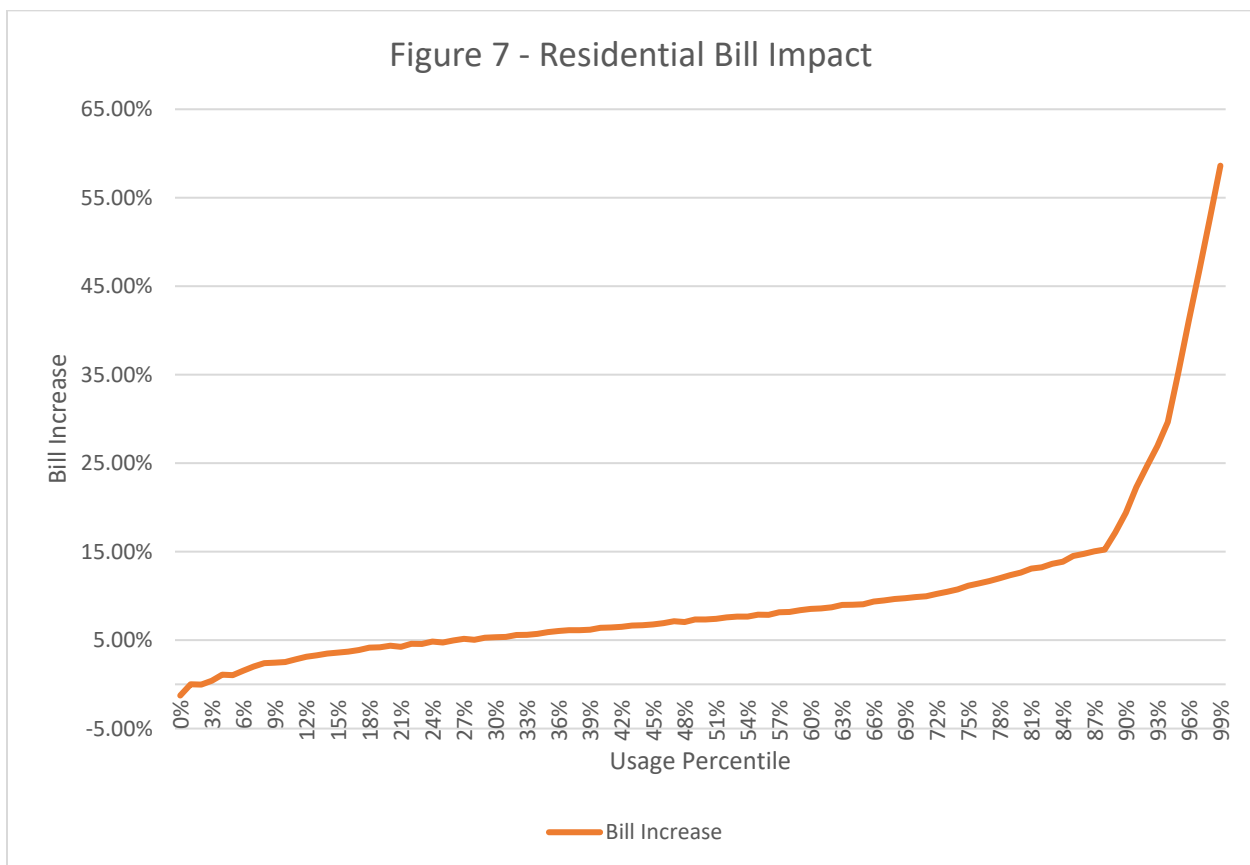


Figure 7 shows the change in residential bills based on the percentile of residential usage. The data was calculated using recent usage data: an old bill and new bill were calculated and then an average percent increase was taken for each usage percentile from 0 to 100.

Commercial Bill Impacts

Approximately 88% of commercial customers are projected to experience an increase in the range between 17% - 30%. The top 10% of commercial customers will see an increase ranging from 30% to 54% (the large spike in figure 1.8), with only the top 1% of users experiencing rate increases above 40%. Prior analysis of the billing data found that the top 1% of customers represented 27% of overall water demand, half of which is commercial use.), so it is reasonable for commercial customers to see their bills rise more than residential customers.

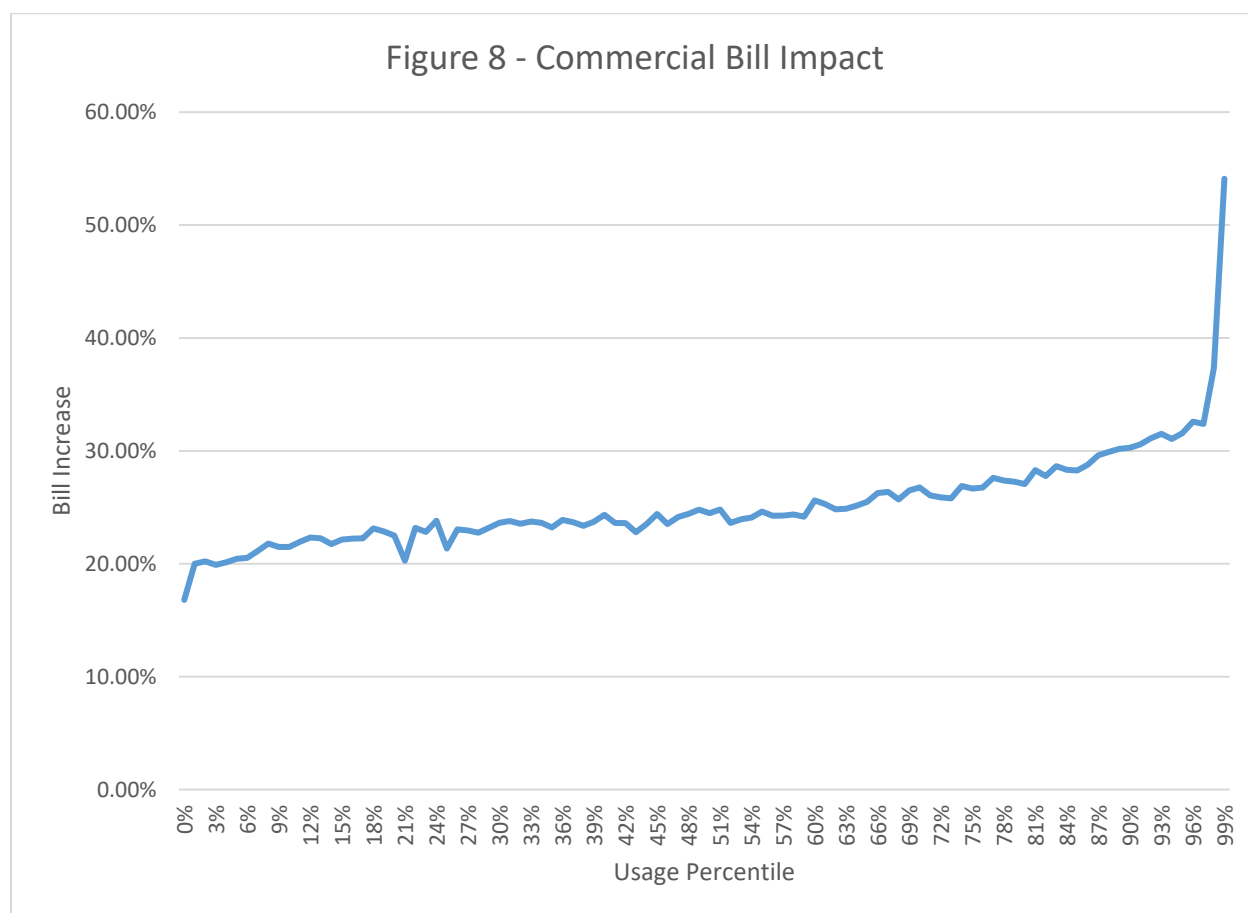


Figure 8 - This figure shows the change in commercial bills based on the percentile of commercial usage. The data was calculated using recent usage data: an old bill and new bill were calculated and then an average percent increase was taken for each usage percentile from 0 to 100.

Irrigation Bill Impacts

Irrigation bills are projected to rise the most, with the percentage impact rising as a customer's usage declines. Overall, this is a result of raising irrigation customer service charges significantly so that they more closely align with other usage classes and other comparable utilities in Texas. In Figure 1.9, the percentage increase is greater as a customer's usage declines since the fixed charge is a much larger portion of a low usage customer's total bill.

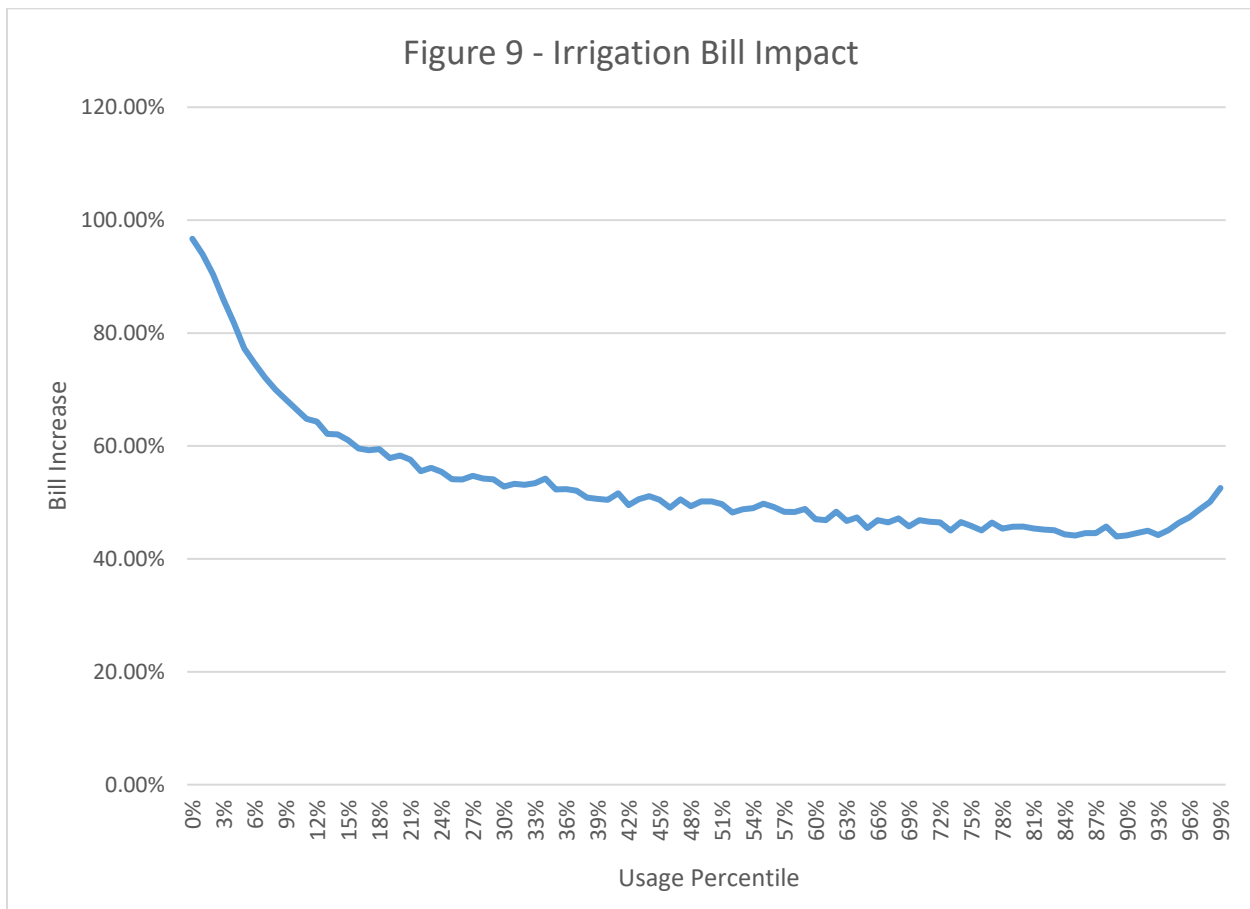


Figure 9 - This figure shows the change in irrigation bills based on the percentile of irrigation usage. The data was calculated using recent usage data: an old bill and new bill were calculated and then an average percent increase was taken for each usage percentile from 0 to 100.

Multi-Unit Bill Impacts

The impact of the new rate structure on multi-unit customers is much more variable (as seen in Figure 10) than the other classes – this is a consequence of collapsing what was previously 11 separate, increasing multi-unit rate structures into a flat rate per thousand gallons for all multi-unit customers.

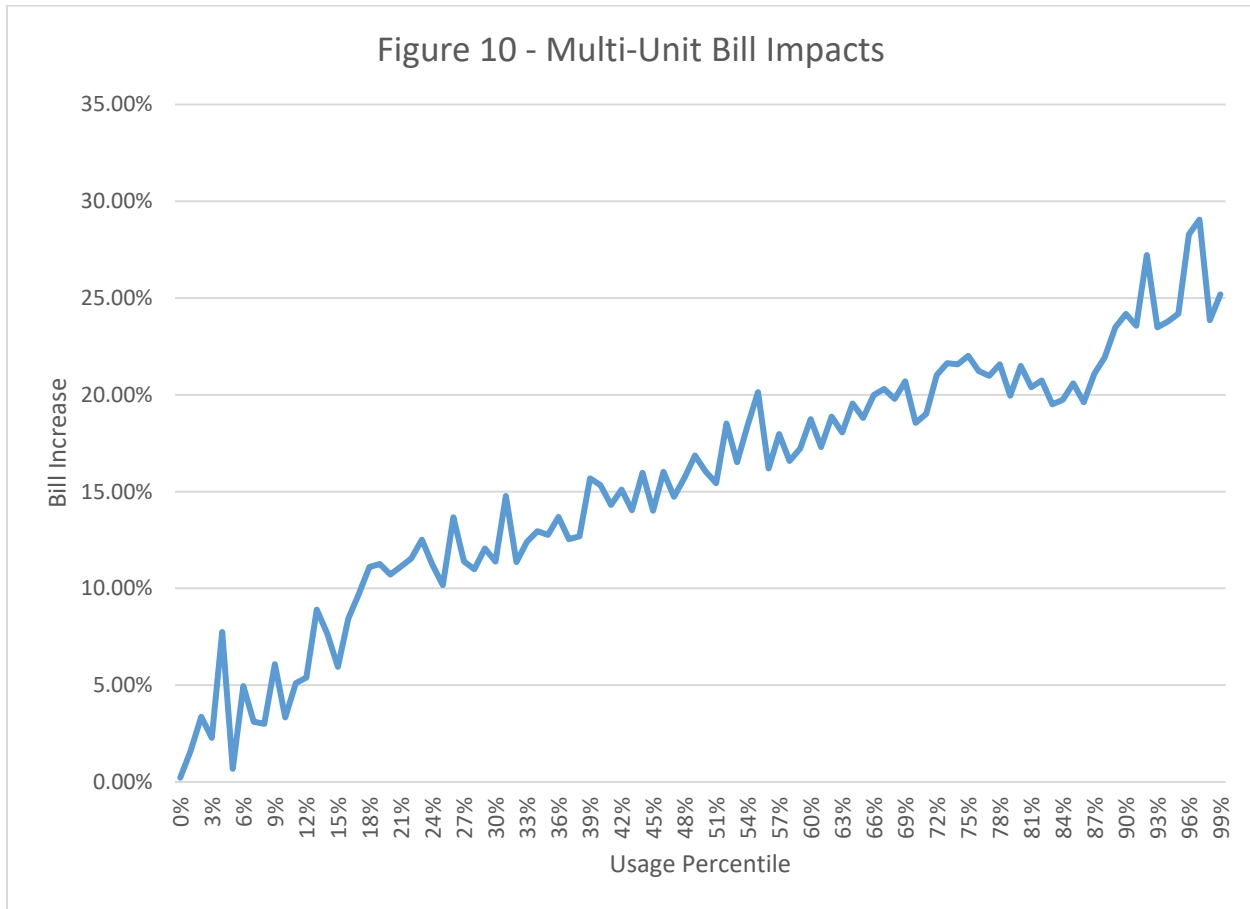


Figure 10 showing the change in multi-unit bills based on the percentile of multi-unit usage. The data was calculated using recent usage data: an old bill and new bill were calculated and then an average percent increase was taken for each usage percentile from 0 to 100.

Figure 11 illustrates a motivation for charging a fixed rate for multi-unit customers. Previously, the variable rate paid per unit of usage would vary arbitrarily according to the number of units, with a range of about \$0.40 per thousand gallons. Under a flat fee, this variation is eliminated.

It is difficult to justify increasing block rate structures for multi-unit customers because most multi-unit buildings have a single meter for the entire building. As a consequence, customers living in larger buildings will pay arbitrarily more for water because total consumption is higher than in a multi-unit building with less tenants. In turn, the increased cost of water is passed on to tenants by the owner/landlord in the form of higher monthly rents. The introduction of a uniform rate structure for multi-unit customers by the ISE was designed to address this issue.

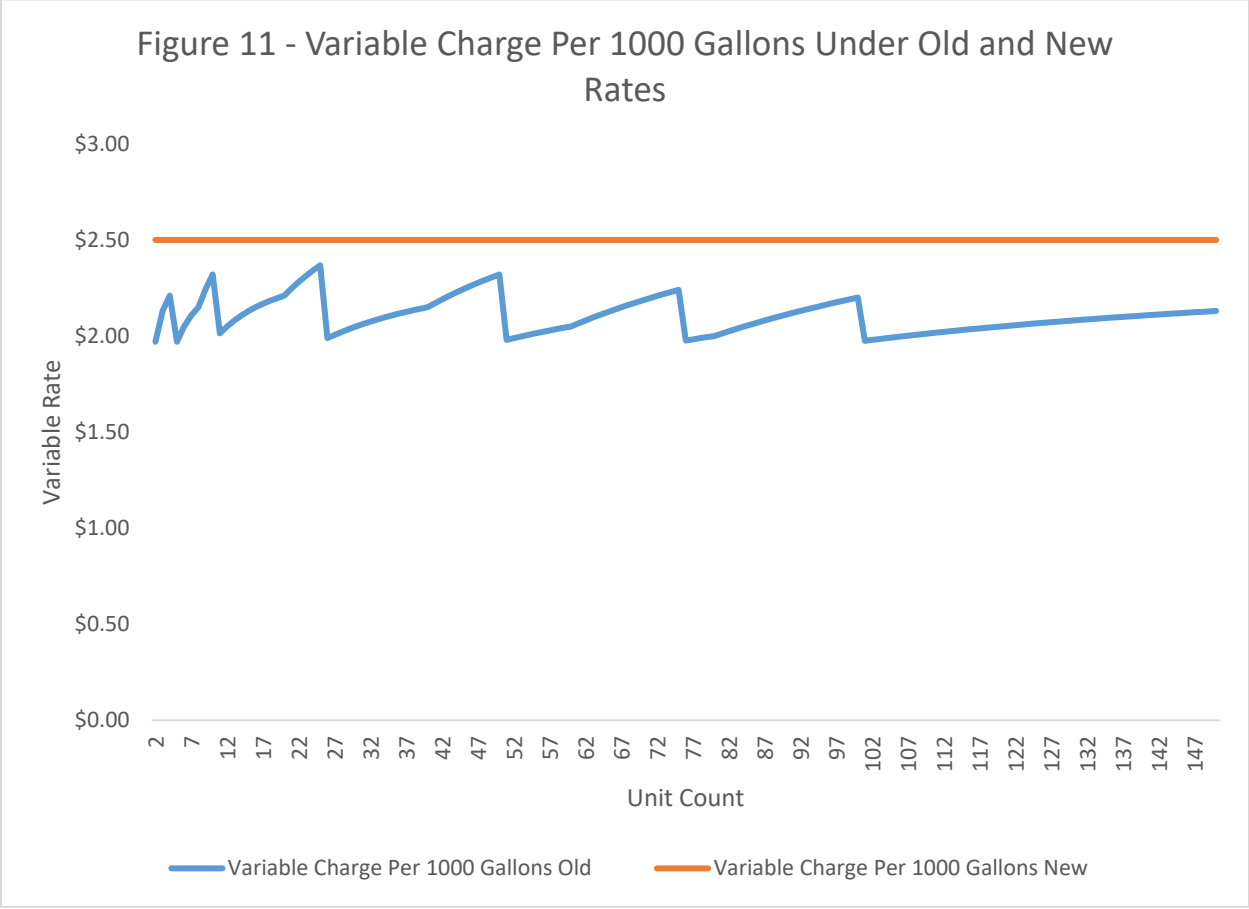


Figure 11 shows the previous cost per thousand gallons consumed (in blue) per the number of units in a multi-unit building, and the new cost in orange.

4.4 Peak demand management

The AWE model allows for consideration of demand elasticities that vary by customer class. In order to estimate the total impact of increased rates and the introduction of peak pricing, the ISE team used the median elasticity suggested for each customer class during peak and off peak seasons and estimated the change in demand for every water bill from FY 2018. The elasticities utilized are listed below:

Water Demand Elasticity Values		
	Off Peak	Peak
Single Family	-.05	-.15
Multi-Unit	-.025	-.075
Commercial/Industrial	-.20	-.20

Landscape	-0.25	-0.25
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Using these elasticities, the AWE model projects that demand during peak months (June 1st - September 30th) will be reduced by 10% (in 2020) under the peak rates compared to demand under the historical rates. This is extremely important because water utilities must size their capacity to accommodate peak demand. A 10% reduction will substantially delay costs associated with additional supplies and infrastructure. Likewise, this reduction will reduce the actual depreciation of capital infrastructure. This will also help to promote water conservation while mitigating future bill impacts for ratepayers.

During off peak months in 2020, the ISE team estimates an aggregate demand reduction of 5%. Annually, water demand will be 7% lower under proposed rates than it would have been under current rates. It is important to note that while these rate increases ensure that future demand is lower under proposed rates than it would have been under current rates, overall volume of water demanded is still projected to rise relative to 2018 and 2019.

Deferring Future Infrastructure Requirements through Peak Pricing

The introduction of peak pricing provides NBU with a powerful tool to increase revenue, promote demand conservation, and delay the purchase of additional water supplies. A typical response to water demand growth is to simply purchase new water supplies and build additional traditional infrastructure. However, this isn't a sustainable solution and moreover, it precludes an integrated One Water approach that might consider many different options and that may require longer timelines for implementation. If NBU continues to purchase additional water supplies and build new infrastructure, the cost of water would continue rising. Likewise, water supplies are limited and new capacity cannot be instantly implemented. As a result, either demand eventually outstrips a finite supply of affordable clean water, or demand growth slows and reveals that the water utility has overinvested in capacity.

With the introduction of peak pricing, NBU can simultaneously address the challenge of new infrastructure requirements and can manage demand. Since water infrastructure capacity is designed to meet the needs of daily and monthly peak demand, NBU can delay the need for additional infrastructure and supply by curbing peak demand. In turn, this will help to address concerns around water scarcity and mitigate further rate increases for customers^{xxxiv}. As NBU continues to grapple with challenges around water in the coming years, the utility can simultaneously address water sustainability challenges and fiscal robustness by adjusting peak rates.

Benefits of a Simplified Rate Structure

The new rate structure is substantially simplified by the elimination of the inside and outside city limit rate differential, and by collapsing the multi-unit rates into one flat fee. In total, the new rate structure reduces the number of fixed rates from 42 to 26 and the number of variable rates from 56 to 26. There are several benefits to the streamlined rates structure. The first is that a simpler billing system is a more accurate billing system and the backend work for NBU's billing department will be easier. Second, the alignment of inside and outside city limit rates and the flattening of multi-unit rates will allow for simpler and more accurate demand and revenue forecasting. This will help NBU to better budget and understand their infrastructure needs. Additionally, NBU may see improved customer satisfaction by providing a simpler billing structure that is easier to understand.

5. CONCLUSIONS

This paper describes analysis that supported a revised rate structure for New Braunfels' Utilities, in order to increase total revenue from \$15,668,000 in FY 2019 to \$20,339,000 in FY 2020 while also working to address broader questions of sustainability (particularly conservation) and equity through the One Water framework. The goals for the revised rate structure were to:

- 1) Meet a 30% increase in revenue requirement.
- 2) Ensure that the impact on customers was equitable.
- 3) Encourage demand conservation.

The new rate structure is projected to meet the revenue requirement with relatively minimal impact upon a majority of NBU's customers by equitably assigning rate increases according to a customer's usage level. This was shown through an analysis of the distribution of bill impacts using historical billing data with the new rate structure. The new rate structure will simultaneously promote conservation and raise revenue by placing the greatest rate increases on the highest users of water. Top users will reduce their usage in response to the rate increases, but will still pay more for their projected water use.

The ISE team also introduced an innovation to NBU's rate structure: peak pricing. During NBU's top four months of historical usage (June 1st – September 30th), rates across all customer classes will be increased. New Braunfels is located in a dry region within Texas and the largest driver of their seasonal, peak demand is irrigation. Given irrigation's sensitivity to rate increases, peak pricing is projected to reduce peak demand and increase revenue in an equitable manner - since peak capacity requirements dictate water infrastructure requirements, and therefore the distribution of costs should also reflect a customer's contribution to peak demand. The reduction in peak demand will also help to defer the purchase of additional infrastructure and supplies. By deferring these costs, NBU can reduce the need for future rate increases.

The new rate structure is significantly simplified. It removes the pricing differential for customers inside and outside city limits and also collapses the previously complex multi-unit rate structure into a uniform rate structure. More importantly, the percentage of revenue estimated to come from fixed revenue increases slightly from prior years. All of this should help to greatly simplify the billing system and to increase the stability of NBU's revenue stream.

APPENDIX

Alliance for Water Efficiency (AWE) Sales and Forecasting Model

Inputs

The AWE Sales and Forecasting Model analyzes the impact of different rate structures on both the volume of water sold and total revenue. It requires several inputs, including: a full year of historical billing data (preferably the most recent year) that is tabulated by customer class, peak vs. off-peak season, and thousand gallon consumption bins). This implies that a peak vs. off-peak season must be defined by the water utility using the twelve months of the year. It also requires the ratio of the total sales volume in the month with the greatest sales volume to the month with the least sales volume. The model also requires the median household income for the customer class which most closely matches residential households in the utility's service area. The total number of water meters for the utility of interest must be tabulated by customer class and meter size and both the current and proposed service charge per billing period for each of those meters must be known. Likewise, the current and proposed rate structure for each customer class must be known. The rate structure can vary with peak and off-peak seasons, or the rate structure can be the same for both seasons. The model also requires at least 15 years of monthly precipitation data and forecasted growth rates for each customer class (including an upper and lower bound).

Outputs

The model predicts the average and median annual service charge per account as well as the total service charge revenue (per bill period and annually). This is tabulated by both customer class and peak vs. off-peak season. It also predicts the total annual sales volume and revenue by customer class for the proposed rate structure and compares it to the current rate structure by listing the values and calculating the percentage change. It further breaks down the revenue by service charges and volume sales for each customer class. It then aggregates and lists total annual sales volume and revenue (breaking it down into both service charges and volume sales) aggregated for all customer classes. The model also provides bill impact charts, which visualize the percentage distribution of bills expected to change (in terms of the cost to the customer) by a particular percentage. Then, based upon the number of simulations you specify (suggested to use 500-1000), it provides a summary of a five year forecast under both current and proposed rates. This includes the average, standard deviation, minimum, and maximum for both the total sales volume and total revenue for both the current and proposed rate structure. There are also summary graphs which show the distribution of each simulation trial for the sales volume and total revenue, for both current and proposed rates and for each forecast year. A 90 percent confidence interval for the sales volume and revenue is provided for each year, under both the current and proposed rate structure. It can also calculate an expected probability of meeting a particular revenue target in the first year, as well as a cumulative revenue target by year 3 or year 5.

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