TWIN CITIES REGIONAL WATER BILLING ANALYSIS 2016

December 2016

The Council's mission is to foster efficient and economic growth for a prosperous metropolitan region

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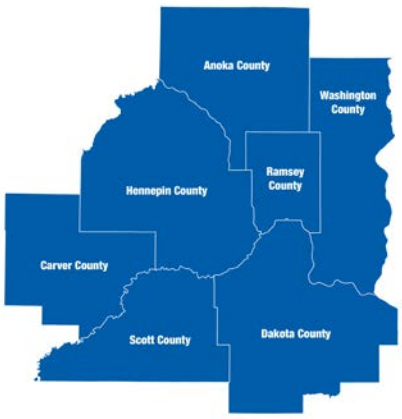

The Metropolitan Council is the regional planning organization for the seven-county Twin Cities area. The Council operates the regional bus and rail system, collects and treats wastewater, coordinates regional water resources, plans and helps fund regional parks, and administers federal funds that provide housing opportunities for low- and moderate-income individuals and families. The 17-member Council board is appointed by and serves at the pleasure of the governor.

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Executive Summary

The Metropolitan Council (Council) commissioned CDM Smith to update information contained in the June 1, 2015 *Twin Cities Regional Water Billing Analysis*. Additionally, CDM Smith was requested to conduct additional analysis on residential water use, research local water conservation programs, develop a water utility look-up tool, develop a residential water rate assessment tool, and conduct a workshop with the topic of development of water conservation utility rate structures. The study was funded by the Council using funds received from the Clean Water Fund.

Data and Sources

The analysis completed in 2015 used data collected through 2014. For the purpose of the 2016 analysis, CDM Smith updated the 2014 data and collected additional data as necessary for in-depth analysis. Data collected for both studies includes water utility rates and rate structures for the various municipal utilities, water consumption data, demographic data, and water treatment plant data. The water consumption and water treatment plant data was updated as a part of this study. The demographic data, based on 2010 census data, was assumed to be unchanged between 2014 and 2016.

In total, 93 municipal utilities have sufficient data to analyze total metropolitan region water use, 93 have sufficient data to analyze per capita water use for total municipal consumption, and 91 have sufficient data to analyze per capita water use for residential consumption only. Data collected was compiled into four sub-databases:

- Utility Rates
- Number of Connections
- Monthly Use
- Water Treatment Characteristics

Water Conservation Programs

The number of water conservation programs grew substantially between 2014 and 2016. For the purpose of this database, Municipal Water Conservation Programs are defined as active programs sponsored by a municipality that offer rebates, audits, financial assistance, and targeted education. It does not include odd/even sprinkling restrictions, rain garden/native landscaping assistance, or general water conservation information on a website. In 2014, CDM Smith documented nine Municipal Water Conservation Programs that met these criteria. This number grew to 26 in 2016. This information is compiled into a separate list that is contained in an appendix to this report.

Analysis

The analysis conducted in 2016 had the purpose to “dig deeper” into the data. The two primary objectives were to assess the average residential water bill for individual water utilities and to assess whether there are any municipal characteristics, such as age of system, that relate to water use.

Conclusions from this analysis include:

- In municipalities where a high volume of use is associated with a low water bill, water is inexpensive and suggests that customers are not facing higher rates for greater water use.
- A higher volume of use is not always associated with a higher water bill.
- There is a trend towards lower average water use in municipalities that have a one dollar or greater increase of price between tiers.
- There is no relationship between the peak month water use and the price step between tiers.

- A review of water use patterns before and after implementation of conservation rate structures for 7 municipalities found that, in most instances, the timing of the rate changes can be associated with declines in total annual water demand.
- The frequency of billing (monthly, bi-monthly, quarterly) shows little difference in the ratio between summer and average winter water use.
- Drought conditions, based on the Palmer Drought Severity Index, does influence monthly water demand.
- There is no significant correlation between water use and the municipal characteristics of changes in population (growth vs non-growth), type of treatment plant, or age of treatment system.

Tools

Two tools were developed for use by Metropolitan Council.

- **Water Rate Look-up Tool** is a series of four queries that allows the user to look-up the following information for each municipality:
    - Average Water Bill
    - Customer Connections and Use
    - Rate Structure
    - Utility Profile
    - Water Rates

  This database is set up to allow the Metropolitan Council to link to their website to create an interactive look-up tool that anyone in the metropolitan region can access.

- **Bill Tabulation Assessment Tool** is a what-if tool for municipal staff to assess the revenue impacts of changing water rates and tier levels for the residential sector.

Case Studies

Two municipalities that implemented changes to their rate structures were selected and investigated to learn the reasons that the rate structure was changed, which rate structures were considered, which were selected, and lessons learned. These communities are Denver, Colorado, and Louisville Water Company, Kentucky. Both municipalities were concerned with volatility of revenue with their previous rate structures and fairness to their users. Each responded that the change was smooth but did result in a large increase in calls to their call-in centers.

Rate Assessment Workshop

The Rate Assessment Workshop was conducted on December 7, 2016 at the Shoreview Community Center. The session was organized for a target audience of financial and non-financial utility managers who have an interest in learning more about tiered rate structures that encourage water efficiency. The number of attendees totaled 67, representing a wide cross-section of water utility responsibilities. These included public works directors, finance managers, city administrators, project engineers, water board members, and water resource staff. Four Professional Development Hours (PDH) credits were offered to attendees through CDM Smith University. Eighteen (18) attendees took advantage of the opportunities to receive these credits.

Introduction

In 2015 the Metropolitan Council commissioned CDM Smith to undertake an analysis of water use in the Twin Cities area. The focus of the original, and this, analysis is residential use. The goal was to determine which factors, if any, affect water use water use patterns and the seasonality of residential water use. That study looked at total water use in the metropolitan region as well as water use for each municipal water utility. Key findings of the 2015 analysis include:

- Monthly water patterns follow a distinct seasonality of water consumption.
- Area-wide peak demand typically occurs in July of each year.
- The peak month to winter average ratios range from 1.4 up to 5.0 with a metropolitan region average of 2.71.
- The general pattern suggests no correlation between the monthly water bill and income.
- No significant pattern was found between the municipal per capita water use and the number of rate structures offered by the municipality.
- No significant pattern was found between the municipal per capita water use and the number of tiers within the rate structure.
- No significant pattern was found between the municipal per capita water use and the percent residential area.
- A positive (increasing) correlation was found between water use and median household income.
- Municipalities tend to have lower per capita residential water use when the percent of income spent on water is above 0.5 percent of income.
- There is a pattern that suggests that as the equivalent monthly water bill increases, the average residential water use per capita decreases, although this pattern is not as evident among the municipalities with lower water bills.
- An analysis of total municipal per capita water use, and residential per capita water use among municipalities with and without irrigation rate structures was inconclusive
- Analysis of the impact of conservation ordinances and programs was inconclusive.

The 2015 study recommended additional in-depth analysis of each municipality's rate structure and water use to identify the effectiveness of conservation based rate structures.

In 2016, the Metropolitan Council commissioned CDM Smith to conduct this additional in-depth analysis. Metropolitan Council was interested in learning:

- Are there any municipal characteristics that affect water use, such as population change (growth, stable, decrease), age of system, or source of water (groundwater vs. surface water)?
- Is there a relationship between summer peak water use and weather?
- What is the average residential water bill for each municipality? And which tier does that average customer fall into?
- Does the change from a uniform rate to a conservation rate affect residential water use?
- Does a seasonal rate structure with higher summer rates affect residential water use?
- Are metropolitan region municipalities creating water conservation programs?
- Are there any non-Minnesota municipalities that have recently changed to tiered rate structures? If so, what have they learned?

Additionally, Metropolitan Council was interested in developing tools to answer frequently asked questions:

- What is the water rate and use in a neighboring municipality?
- Will change to a conservation rate structure cause a decrease in revenue?

This report summarizes the in-depth analysis conducted in 2016. Also included is a description of the tools developed and of the water conservation rate workshop that was conducted.

Sources of Data and Data Review

For the purpose of the 2016 analysis, CDM Smith updated the 2014 data and collected additional data as necessary for in-depth analysis. The sources of information and definitions used in this updated report are the same as the 2015 report. Data collected for both studies includes water utility rates and rate structures for the various municipal utilities, water consumption data, demographic data, and water treatment plant data. This section highlights the changes that have occurred between 2014 and 2016.

Data Sources

CDM Smith collected data for 2015 and 2016 from the three sources listed below and used this data to supplement or update the databases utilized in the June 2015 analysis.

- **Individual Municipal Utilities**: The billing rates, rate structures, and other fees associated with water utility bills for each of the municipal utilities in the metropolitan region were obtained from municipal websites and/or direct contact with the utility. The use of a city ordinance or fee schedule was the preferred source of information. When this was not available, the information was gathered from either the municipality's utility webpage or direct conversations with a utility representative. In total, information was gathered on 182 municipalities in the metropolitan region. Additionally, water conservation information was obtained for those municipalities with a water conservation program.
- **Minnesota Department of Natural Resources (DNR)**: Monthly and yearly water consumption, number of utility connections based on customer class, and water consumption by customer class for the various municipal utilities in the metropolitan region were collected from the Minnesota Department of Natural Resources (MNDNR) Permitting and Reporting System (MPARS). This system is an updated version of the State Water Use Database System (SWUDS) that was referenced in the June 2015 report. MPARS is a database that stores data regarding the amount of water that a permittee, in this case a municipal utility, withdraws from rivers or aquifers, as well as other data. It also tracks the amount of water each municipal utility delivers to each customer class. All data is classified by permit number, which relates to a specific municipality. In total, information regarding monthly use data was collected for 101 municipal utilities, and information regarding number of connections and volume was collected for 93 municipal utilities.
- **Minnesota Department of Health (MDH)**: The number of treatment plants within a municipality (if any) and treatment plant characteristics including treatment begin date, water source, design capacity, average daily production, number of wells, number of residential service connections, and other infrastructure associated with the plant were obtained from the Minnesota Department of Health. In total, information was gathered for 109 municipal utilities.

The June 2015 report included socio-economic data obtained from Metropolitan Council. This information was assumed to be current in this analysis; therefore, no additional data was obtained.

Municipal Water Utilities

The total number of municipalities has been adjusted slightly based on updated information and corrections. The following changes were made to the inventory of metropolitan region municipalities:

- Northfield, Hanover, New Prague, and Rockford are not within the jurisdiction of the Metropolitan Council and were removed from the list.
- Corcoran was incorrectly categorized as a municipality without a municipal water supply.

- Greenwood was added to the list of municipalities without a municipal water supply.

This accounted for 55 municipalities without a central water supply, which are listed in Table 1.

Table 1 – Municipalities without Municipal Water Systems in the Metropolitan Region (55)

Afton	Helena Township	Stillwater Township
Baytown Township	Hollywood Township	Vermillion Township
Belle Plaine Township	Independence	Waconia Township
Benton Township	Jackson Township	Waterford Township
Bethel	Laketown Township	Watertown Township
Blakely Township	Linwood Township	West Lakeland Township
Camden Township	Louisville Township	Young America Township
Castle Rock Township	Marshan Township	
Cedar Lake Township	May Township	
Coates	Medicine Lake	
Credit River Township	Miesville	
Dahlgren Township	New Market Township	
Dellwood	Niniger Township	
Denmark Township	Nowthen	
Douglas Township	Pine Springs	
Eureka Township	Randolph Township	
Gem Lake	Ravenna Township	
Grant	San Francisco Township	
Greenvale Township	Sand Creek Township	
Greenwood	Scandia	
Grey Cloud Island Township	Sciota Township	
Ham Lake	Spring Lake Township	
Hampton Township	St. Lawrence Township	
Hancock Township	St. Mary's Point	

Of the 182 municipalities in the metropolitan region, the remaining 127 operate a municipal water system. Information could not be obtained for 5 of these municipalities: Fort Snelling, Lake St. Croix Beach, Landfall, North Oaks, and Willernie. Billing rates and rate structures were not provided on their websites, nor was successful contact made with anyone working for those municipalities. As a result, it was not possible to confirm whether these 5 municipalities have the same rates and structures as the municipality from which they purchase water. In total, there are 122 municipalities included in this analysis.

Note the use of the terms municipality and municipal utility. For the purpose of this study, a municipality is a city, town, or township. A municipal utility is a governmental organization that provides public utilities to its residences and charges the customers for use of these utilities.

Data Caveats and Discrepancies

Some municipalities purchase their water from other municipal utilities. In these situations, information was not available for the purchaser in the MPARS database because when one municipality purchases its water from another municipality, the amount of water used and number of connections for the purchasing municipality is contained within the seller's permit number and cannot be separated out. Those municipalities that purchase water are listed below.

- **Birchwood Village**: Purchases water from White Bear Lake.
- **Columbia Heights**: Purchases water from Minneapolis.
- **Crystal**: Purchases water from Minneapolis.
- **Deephaven**: Purchases water from Minnetonka and Shorewood.
- **Falcon Heights**: Purchases water from Saint Paul.
- **Fort Snelling**: Purchases water from Minneapolis.
- **Golden Valley**: Purchases water from Minneapolis.
- **Hilltop**: Purchases water from Minneapolis.
- **Lakeland Shores**: Purchases water from Lakeland.
- **Lake St. Croix Beach**: Purchases water from Lakeland.
- **Landfall**: Purchases water from Oakdale.
- **Lauderdale**: Purchases water from Saint Paul.
- **Lilydale**: Purchases water from Saint Paul.
- **Little Canada**: Purchases water from Saint Paul.
- **Maplewood**: Purchases water from Saint Paul, North Saint Paul, and Woodbury.
- **Mendota**: Purchases water from Saint Paul.
- **Mendota Heights**: Purchases water from Saint Paul.
- **New Hope**: Purchases water from Minneapolis.
- **Newport**: Purchases water from Saint Paul.
- **North Oaks**: Purchases water from White Bear Township.
- **Osseo**: Purchases water from Maple Grove.
- **Roseville**: Purchases water from Saint Paul.
- **South Saint Paul**: Purchases water from Saint Paul.
- **Sunfish Lake**: Purchases water from Saint Paul.
- **West Saint Paul**: Purchases water from Saint Paul.
- **Willernie**: Purchases water from Mahtomedi.
- **Woodland**: Purchases water from Minnetonka.

For those municipal utilities that supply water to retail customers, as well as those municipalities who supply water to retail and wholesale customers, a detailed analysis of the data contained in the MPARS database found missing data, errors, and/or discrepancies. Errors that were obvious and easy to fix,

such as decimal point errors associated with volume of water used, were corrected before the analysis was completed. Other data that were clearly in error, but not fixable, were removed from the analysis. In other instances, data were missing for entire municipalities. Municipal utilities included on the list above, which purchase water from neighboring municipalities, plus the following municipal utilities with insufficient data were not included in any water use analysis due to lack of data in the MPARS database:

- **Arden Hills**: No MPARS data was available for this municipality.
- **Corcoran**: No MPARS data was available for this municipality.

Two exceptions to this include Deephaven (Minnetonka) and Osseo, both of which were included in the MPARS Monthly Usage analysis.

The following municipal utilities were included in the analysis but with limited data from the MPARS database:

Monthly Use

- **East Bethel**: MPARS data for only 2014 and 2015.
- **Marine on St. Croix**: MPARS data for 2009 through 2015.
- **Deephaven**: MPARS data does not include 2013 through 2016.
- **Osseo**: MPARS data does not include 2013 through 2016.
- **Saint Paul**: MPARS data does not include 2013 through 2016.

Number of Connections and Volumes

- **Marine on St. Croix**: MPARS data includes 2003, 2005, and 2013 through 2015.

In total, 93 municipal utilities have sufficient data to analyze total metropolitan region water use, 93 have sufficient data to analyze per capita water use for total municipal consumption, and 91 have sufficient data to analyze per capita water use for residential consumption only. Appendix A contains a list, by municipality, of the sufficiency of the MPARS and MDH data for each municipality.

Municipal Water System Characteristics

Minnesota Department of Health data was collected in order to understand the characteristics of a municipal utility. The data provided information on the treatment plant characteristics including: date of most recent plant upgrade, source of water (groundwater or surface water), plant capacity, average water volume treated each year, and number of wells (for groundwater systems). This database contains additional information that duplicates the MNDNR MPARS data. Where duplicate data existed, the MPARS information was used for this analysis. Municipalities that purchase their water from another utility or have private wells are not included with this database. In total, CDM Smith obtained information for 109 municipal utilities.

Water Conservation Programs

The number of water conservation programs grew substantially between 2014 and 2016. CDM Smith inventoried three general categories of water conservation programs:

- Municipal Water Conservation Programs
- Energy Company Water Conservation Programs
- MNTAP Water Conservation Grant Programs

For purpose of this database, Municipal Water Conservation Programs are defined as active programs sponsored by the municipality that offer rebates, audits, financial assistance, and targeted education. It does not include odd/even sprinkling restrictions, rain garden/native landscaping assistance, or general water conservation information on a website. In 2014, CDM Smith documented nine Municipal Water Conservation Programs that met these criteria. This number grew to 26 in 2016.

The 2016 inventory of water conservation programs was expanded to include four energy companies (Xcel Energy, Neighborhood Energy Connections, CenterPoint Energy, and Minnesota Energy Resources) and one non-profit organization (Neighborhood Energy Connections). Although the primary focus of these programs is energy efficiency, these organizations also provide water efficiency improvements in the form of dishwasher and clothes water rebates, and low flow faucet aerators and showerheads.

The third category of water conservation programs researched in 2016 includes Minnesota Technical Assistance Program (MNTAP) projects developed by the University of Minnesota. These efforts began in 2013 as a collaboration between the Metropolitan Council and MNTAP. Each year, University of Minnesota interns are assigned to local industries to conduct water audits and propose efficiency solutions. To date, this program has assisted 20 metropolitan region industries in the identification of water efficiencies.

Appendix B contains a full list of these programs.

Database Description

The data collected in 2016 was compiled into four different sub-databases which are described below.

- **Utility Rates**: This database lists each of the rate structures that each municipal utility in the metropolitan region uses to bill their water customers. Each unique rate structure managed by a specific municipal utility is listed as a separate rate structure. For example, Blaine has established two separate rate structures, one for residential customers and a second for commercial customers. In this situation, the database recognizes two rate structures. The 182 municipalities in the metropolitan region manage a total of 332 rate structures.
- **Number of Connections**: This database contains information on the number of water utility connections and volume of water used per customer class for individual municipal utilities as reported in the MNDNR MPARS database. Information contained in this database dates between 1993 and 2015. It should be noted that not all municipalities have data that dates to 1993.
- **Monthly Use**: This database contains information regarding the total volume of water that each municipal utility used per month for each year that they reported the data to the MPARS database. Information in this database dates between 1988 and 2015.
- **Water Treatment Characteristics**: This database contains information regarding whether or not a municipality has its own treatment plant, and if so, it provides information regarding the treatment plant.

Appendix C contains a list of the fields that are contained in each of these databases.

Summary

This analysis is based on the metropolitan region municipalities, as detailed in Table 2. Data from a total of 182 municipalities were reviewed in this analysis; less than the 186 reviewed in 2014.

Table 2 – Total Number of Municipal Water Utilities in the Metropolitan Region

Municipal Water Utility Type	2014 Count	2016 Count	Change
Stand-alone municipal water utilities	90	88	▪ Removed New Prague because it is not within the Metropolitan Council area. ▪ Moved Arden Hills, Corcoran, and Excelsior to stand-alone water utility list. ▪ Moved Newport and South St. Paul to purchases water utility list. ▪ Moved Shorewood and Woodbury to sells water utility list.
Municipal water utilities that sell water to other utilities	11	12	▪ Moved Excelsior to stand-alone water utility list. ▪ Moved Shorewood and Woodbury to sells water utility list.
Municipal water utilities that purchase water from others	27	28	▪ Moved Arden Hills to stand-alone water utility list. ▪ Moved Newport and South St. Paul to purchases water utility list.
Municipalities with no municipal water system	58	54	▪ Moved Corcoran to stand-alone water utility list. ▪ Removed Hanover, Northfield, and Rockford because these are not within the Metropolitan Council area.
Total number of municipalities	186	182	▪ Removed Hanover, Northfield, New Prague, and Rockford because these are not within the Metropolitan Council area. ▪ Added Greenwood to list of municipalities.

Analysis

Description of Terms

Water utilities must charge their customers in order to build, maintain, and improve their water infrastructures. These charges are based on the utility's water rate structure. Within this report, the following terms apply:

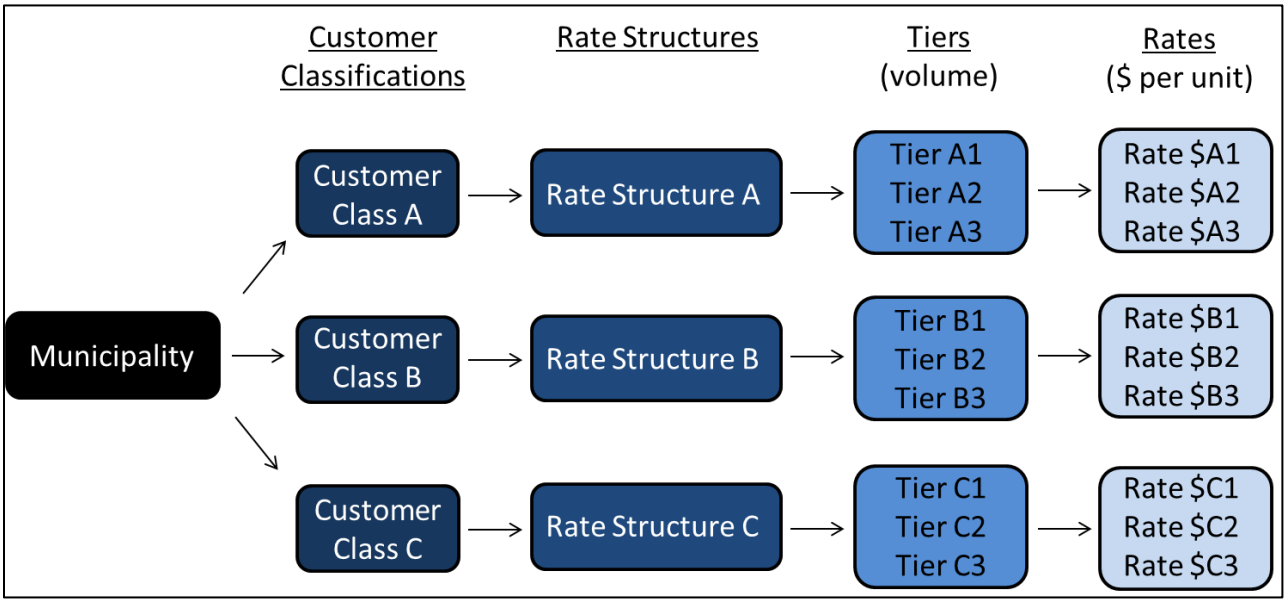
- **Customer Class**: The way in which a municipal utility classifies it customers. Some utilities do not have any type of distinction between their customers so all customers are billed using the same rate structure. Other utilities may break up their customers into different classes and use a different rate structure to charge each class. Land use/building type and meter size are two ways in which municipal utilities in the metropolitan region classify their customers.
- **Rate Structure**: The method used by the utility to charge the customers within a given customer class. The volume-based portion of the water rate structures in the metropolitan region are either uniform, increasing, or seasonal. Some water rate structures in the metropolitan region also include a base, or fixed, charge.
- **Tiers or Blocks**: The volume of water at which a customer is charged a specific rate.
- **Rate**: The charge for a unit of water, usually defined as dollars per hundred cubic feet (ccf) or dollars per 1,000 gallons (kgal) for a given tier.

- **Base Charge or Service Fee**: A dollar amount charged per billing period regardless of the volume used.

This is the same terminology as used in the June 2015 *Twin Cities Regional Water Billing Analysis*.

Figure 1 shows how these terms relate to each other in regards to how a municipal utility bills its customers.

Figure 1 – The Relationship between Customer Classifications, Rate Structures, Tiers, and Rates



As described above, a municipality is a city, town, or township. A municipal utility is a governmental organization that provides public utilities to residences and businesses, and charges the customers for use of these utilities. A municipal utility may supply water to residential, commercial, industrial, and institutional customers, and some municipal utilities may even have agricultural customer accounts or wholesale customers.

Rate Structure Review

There are 123 municipal utilities with information for this analysis. Each municipal utility has one or more rate structures, primarily set up for different customer classes or meter size. In total, the 123 municipal water utilities manage 273 separate water rate structures.

Of the 123 municipal utilities, 55, or 45 percent, have only one rate structure, 26, or 21 percent, have two different rate structures, and 20, or 16 percent, have three rate structures. The remaining 22, or 15 percent, have between four and nine rate structures. One utility (Crystal) has as many as nine different rates, including six different non-residential rate structures based on meter size.

Table 3 breaks down the number of municipal utilities according to the number of rate structures managed by each utility. Table 4 breaks down the rate structures according to the number of tiers within that rate structure.

Table 3 – Number of Municipal Rate Structures

Number of Rate Structures per Utility	Number of Utilities	Percent of Utilities	Total Number of Rate Structures
1	55	44.7%	55
2	26	21.1%	52
3	20	16.3%	60
4	14	11.4%	56
5	4	3.3%	20
6	1	0.8%	6
7	1	0.8%	7
8	1	0.8%	8
9	1	0.8%	9
Total	123	100%	273

Table 4 – Number of Rate Tiers in a Rate Structure

Number of Tiers	Number of Rate Structures	Percent of Rate Structures	Percent of Tiered Rate Structures
1	85	31.1%	-
2	37	13.6%	19.7%
3	83	30.4%	44.1%
4	40	14.7%	21.3%
5	23	8.4%	12.2%
6	2	0.7%	1.1%
7	1	0.4%	0.5%
8	1	0.4%	0.5%
9	0	0.0%	0.0%
10	1	0.4%	0.5%
Total	273	100%	100%

The following represents the range of features found among the rate structure designs used in the metropolitan region:

- **Customer Classes**: There are numerous combinations of customer classifications. Of the 273 various rate structures, 54, or 20 percent, are designated for all customers, including those with exceptions (e.g., all except multi-family, all except irrigation). Rate structures designated specifically for residential customers, including some specifically for apartments, multi-family, and both in and out of city residents total 73, or 27 percent. There are a similar number of rate structures (approximately 27 percent) designated for non-residential customers, which includes a range of specific meter sizes, with and without irrigation, in and out of city, schools, and hotels. There are 42, or 15 percent, of rate structures designated for irrigation meters, which includes various meter sizes, as well as specific residential, commercial, institutional, or industrial irrigation. Designation based on meter size is used in 22, or 8 percent, of the rate structures, which includes irrigation meters of different sizes, and designated commercial industrial meters by size.
- **Billing Volume**: Approximately 90 percent of rate structures are designated in gallons, or 1,000 gallons (kgal). The remaining 10 percent are designated in cubic feet or 100 cubic feet (ccf).
- **Billing Cycle**: Approximately 57 percent of rate structures are on a quarterly billing system, approximately 35 percent bill monthly, and approximately 4 percent bill bi-monthly. The remainder, approximately 4 percent, are a mix such as residential-monthly/commercial quarterly, or quarterly in winter months.
- **Uniform vs. Tiered Rate Structure**: Eighty-five, or 31 percent, of the rate structures consist of a uniform rate structure with the same volumetric rate applied to all water volume used in a given billing period. Tiered rate structures with increasingly higher rates for higher tiers of water use are used in 188, or 69 percent, of the rate structures. No rate structures were identified with a declining rate structure.
- **Number of Tiers**: Approximately 20 percent of the rate structures with tiers have only two tiers, 44 percent of the tiered rate structures have three tiers, and another 34 percent have either four or five tiers. The remaining 2 percent consist of five rate structures that have from six to ten tiers.

Another aspect of municipal water rates is that some utilities offer special discounts for residential customers who are senior citizens or have disabilities. Nine municipal utilities in the metropolitan region offer such discounts. Four of the nine offer reduced (or eliminated) base charge, while five of the nine offer reduced volume rates.

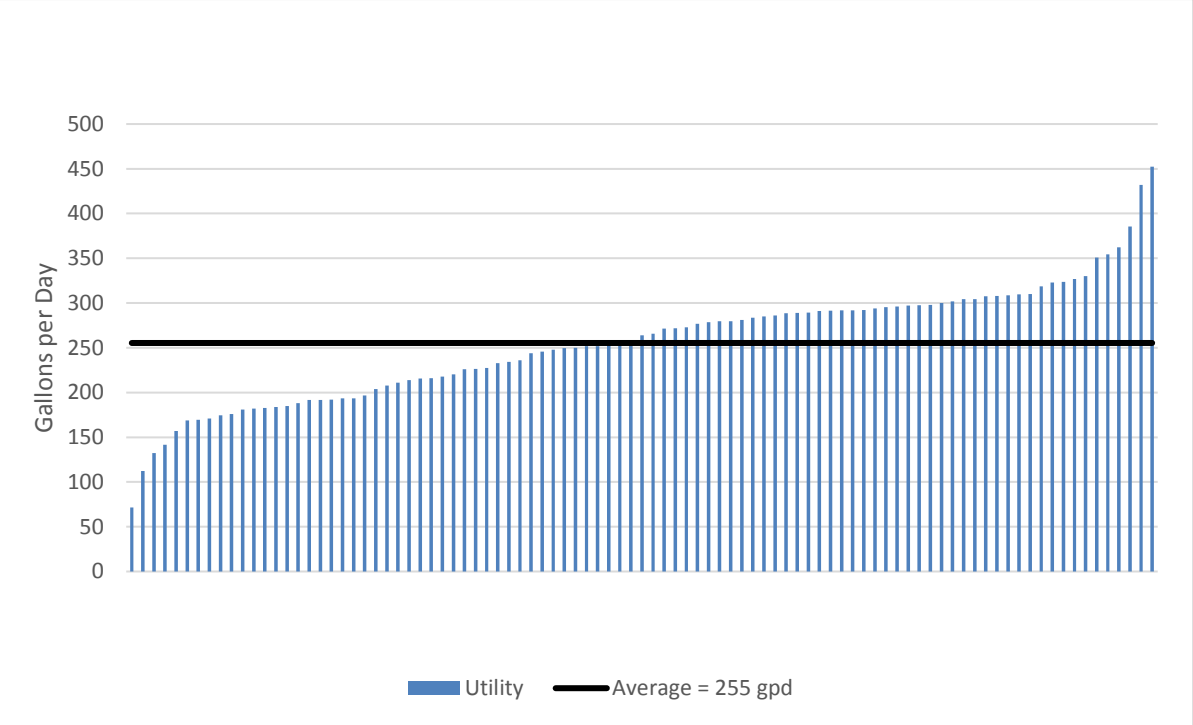
Average Water Use

MPARS data on the number of connections and volume by utility includes the population served, residential gallons, number of residential connections, and number of residential meters for multiple years for each utility. Water use data was matched with rates according to the CTU ID number. The prior study reported a 12-year average residential water use (2000 to 2012). Therefore, data from 2003 through 2015 were used to develop a comparable updated 12-year average for each municipal utility. The population and residential data were pulled and matched with rate information. For some municipal utilities, there was rate information but no water use data (e.g., Arden Hills). For some municipal utilities, the water use information was incomplete (e.g., Bayport had residential volume but not the number of residential connections or meters). If the utility had multiple rates, the residential water use was matched with rates that were designated as residential, single-family, or matched by the smallest meter size (5/8-inch or ¾-inch). Residential water use and rates were matched for 93 municipal utilities.

Generally, the number of residential connections and residential meters were the same. However, where there was a discrepancy, or one value was missing, the larger of the two values was used, and divided into the annual residential consumption to derive an estimated residential gallon per day per connection (Res GPD per connection). The resulting estimates were reviewed and in some instances water use data from a prior year was used if the gpd value was out of range (usually extremely low).

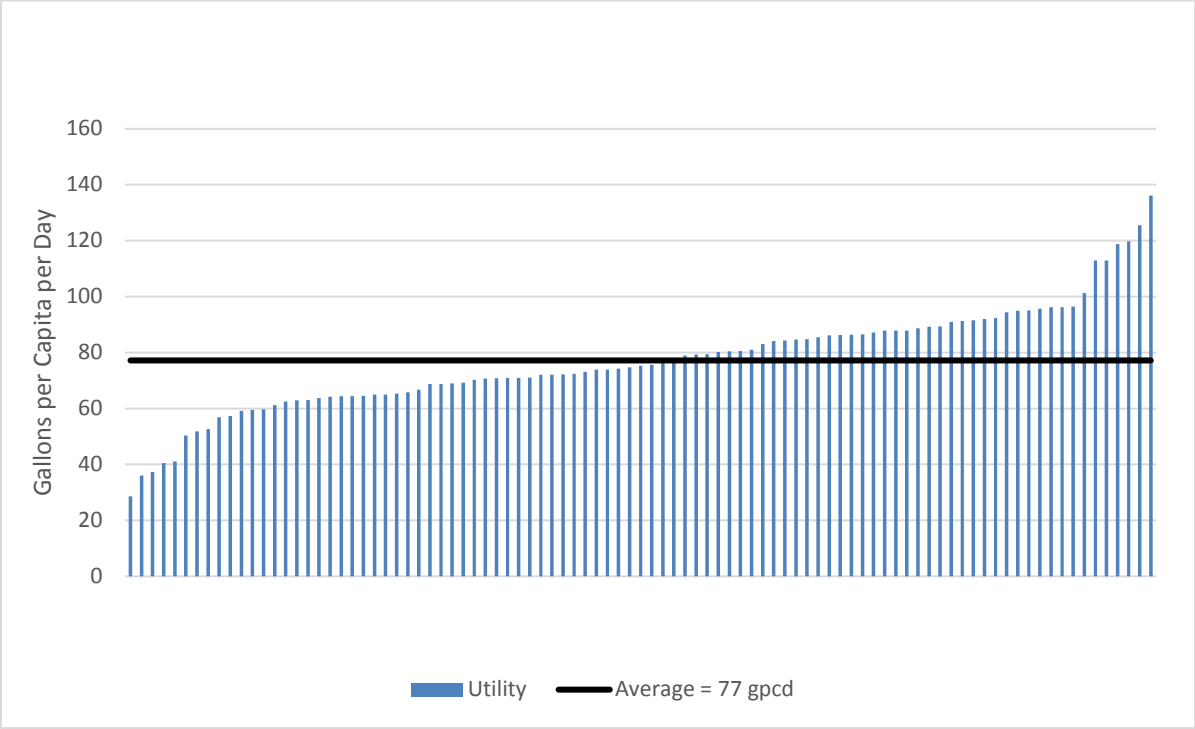
Overall, the Res GPD per connection ranged from 71 gpd (Columbus) up to 452 gpd (Wayzata). The overall average is about 255 gpd, or approximately 7,752 gallons per month, with a median value of 264 gpd. The range of water use in Res GPD per connection among the utilities is shown in Figure 2 with the average shown as a black horizontal bar.

Figure 2 – Residential Gallons Per Day Per Connection (2003 through 2015)



Dividing the residential water use per day by population served for each municipal utility resulted in a residential gallons per capita per day (gpcd) estimate that ranged from 29 gpcd (Greenfield) up to 136 gpcd (Wayzata) with an average of 77 gpcd for residential use, which in in-line with average single-family household water use. This range is shown in Figure 3.

Figure 3 – Residential Gallons Per Capita Per Day (2003 through 2015)



Estimated Average Monthly Water Bill

The estimated Res GPD per connection of each municipality was re-estimated with data for the year 2015, or the most recent year with available data. This estimate of Res GPD per connection was used in conjunction with the corresponding rate data to estimate an average residential monthly water bill for each municipality. The estimated gallons per day was multiplied by 30.4 (average days per month) to derive an estimated monthly water use volume for an average residential customer for each utility. These volumes ranged from 1,770 gallons per month (Columbus) to 10,275 gallons per month (Andover), with an overall average of 6,288 gallons per month. This average monthly use is an annual average; thus, the estimated water bill based on the average annual use represents an average annual monthly water bill that reflects both winter and summer water use.

As noted above, some utilities bill quarterly and some have rates in cubic feet, or hundred cubic feet (ccf). For those utilities that bill bi-monthly, or quarterly, the volumetric size of each tier was adjusted to a monthly volume. For those utilities that bill in cubic feet, the estimated monthly volume was calculated based on the use in ccf. Thus, an equivalent monthly water bill was estimated for each municipal utility.

Typically, water bills include a monthly service charge, or base fee, plus a volumetric charge by tier. The estimated monthly service charge is unique for each utility, and the tier rate structure and the volume “width” of each tier is also unique for each utility. Note that this analysis is a simple comparison of monthly bills and does not take into account other factors that affect the bill, including the costs to provide the water service.

Twenty, or 22 percent, of the 93 municipal utilities have uniform rates, meaning that all volume is charged at the same unit rate. Most of the rates (78 percent) are tiered rates, as shown in Table 5.

Table 5 – Rate Structures for Utilities with Available Residential Water Use Data

Uniform	20	21.5%
Tiered	73	78.5%
Total	93	100%

In addition, 18, or 19 percent, of these 93 residential municipal rates include a base volume in the fixed service charge. That is, there is a base volume with no volumetric charge, and so the volumetric charge is calculated after this base volume is used. Thus, the volumetric charge associated with Tier 1 applies to volumes of use greater than the base volume. For example, Bloomington has a service fee of $11.28 which includes a first 4,000 gallons (billed bi-monthly), followed by a Tier 1 rate of $2.82 per 1,000 gallons for use from 4,001 to 18,000 gallons, and a Tier 2 rate of $4.99 per 1,000 gallons for use above 18,000 gallons. The first 4,000 gallons that is included in the service fee is referred to as the "base volume."

Of those 18, about one-quarter (28 percent) are uniform rates and the majority (72 percent) are tiered rates, as shown in Table 6.

Table 6 – Utilities with a Base Volume

Uniform	5	27.8%
Tiered	13	72.2%
Total	18	100%

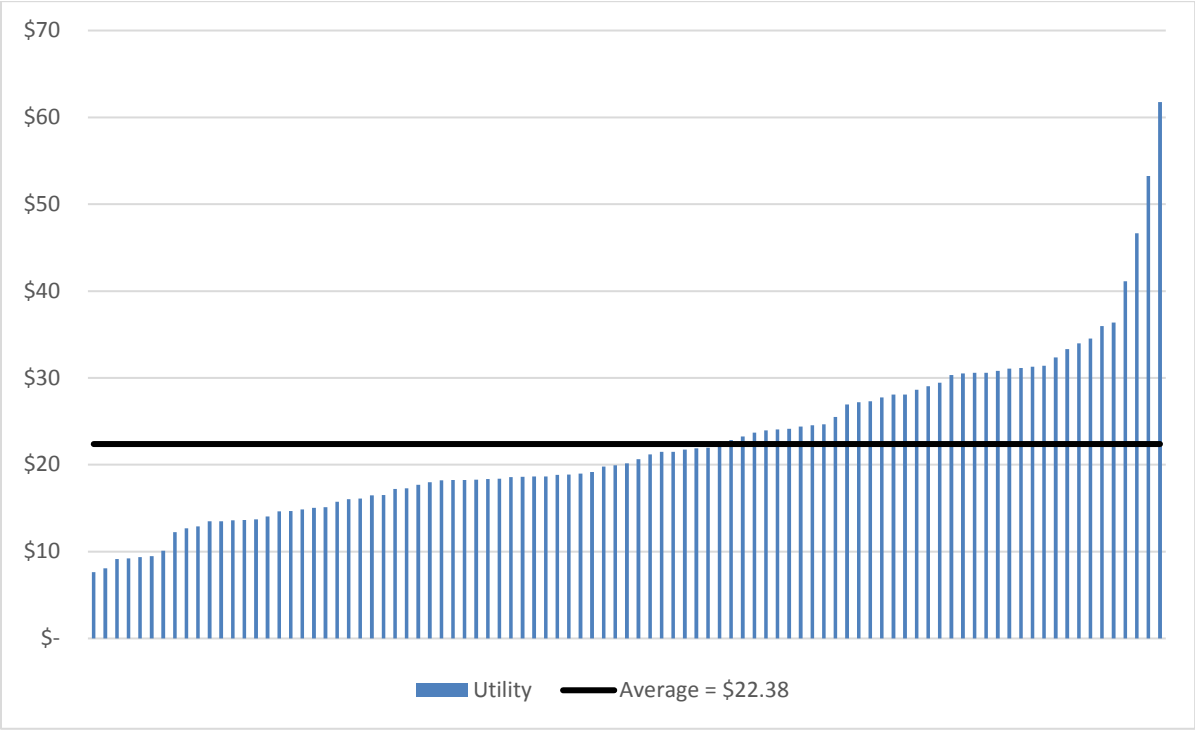
Continuing with this example, Bloomington shows an average annual water use per residential connection of approximately 232 gallons per day, or about 7,065 gallons per month. The calculated equivalent monthly bill is illustrated in Table 7. Note that the service fee and the tier volumes for the bi-monthly schedule are converted to monthly equivalents (half). In this example, the average monthly residential use falls in the first tier, after accounting for the base volume. The equivalent monthly water bill is $19.91.

Table 7 – Example of Calculating the Equivalent Monthly Bill

	Bi-Monthly Volume	Rate	Monthly Use (adjusted)	Monthly Charge (adjusted)
Service Fee with Base Volume	0 – 4,000	$11.23 / bi-monthly	2,000	$5.62
Tier 1	4,001 – 18,000	$2.82 / kgal	5,065	$14.29
Tier 2	18,000 and greater	$4.99 / kgal	-	-
Total			7,065	$19.91

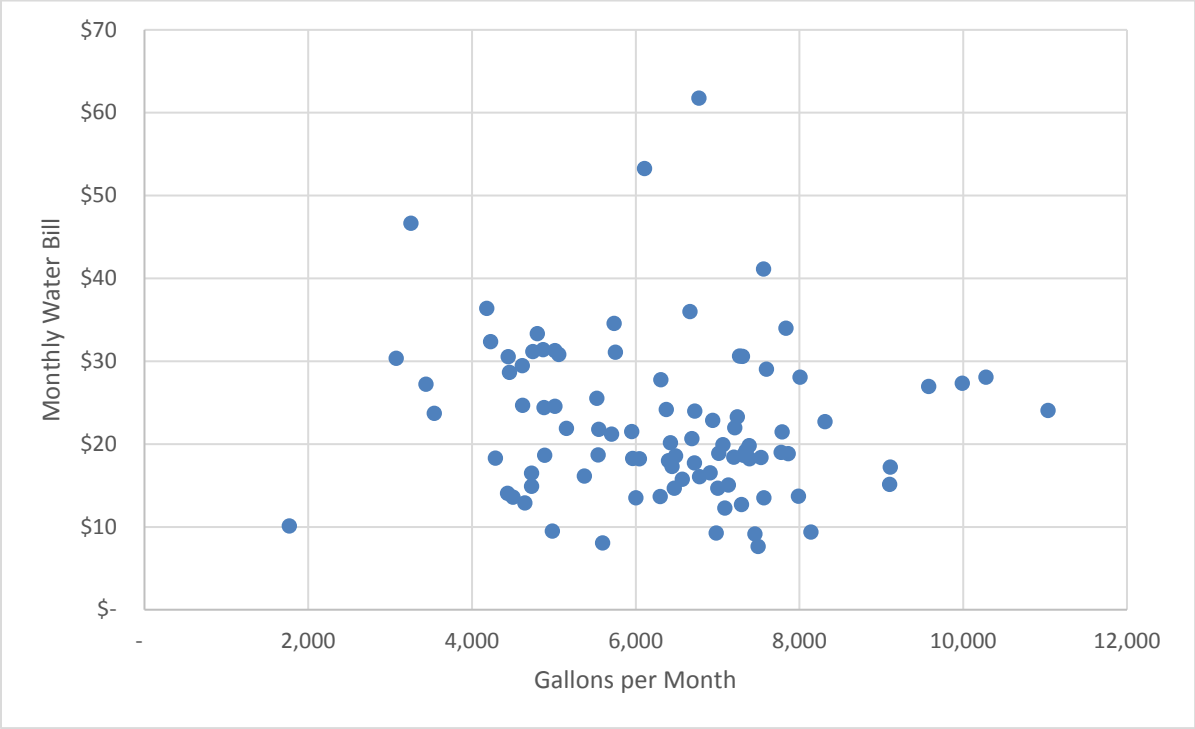
This approach was used to estimate an average residential monthly water bill for the 93 utilities with data, as shown in Figure 4. The estimated average monthly water bill for the residential rates matched with water use data ranged from $7.63 (Woodbury) to $61.76 (Saint Francis) with an overall average of $22.38. Six municipalities have average monthly residential water bills below $10 and four have monthly water bills above $40.

Figure 4 – Average Residential Monthly Water Bill



It is interesting to note that a higher volume of use is not always associated with a higher water bill as one might expect. For example, the municipality with the highest monthly water bill has relatively average water use. Additionally, there are many other municipalities that experience higher than average water use that have low monthly bills. Municipalities with average monthly residential water bills of $10 or less range in water use from 1,770 to 8,142 gallons per month. A plot of the monthly volume versus the monthly bill is shown in Figure 5.

Figure 5 – Monthly Residential Volume Used versus Monthly Bill



In municipalities where a high volume of use is associated with a low water bill, water is inexpensive and suggests that customers are not facing higher rates for greater water use. None of the nine municipalities with average residential use over 8,000 gallons per month have water bills exceeding $30 per month. Table 8 and Table 9 list monthly water volumes and associated monthly water bills for the five municipalities with the highest and lowest use and the highest and lowest water bills.

Table 8 – Highest and Lowest Monthly Residential Water Use

Municipality	Monthly Bill Volume (gallons)	Average Monthly Bill
Andover	10,276	$28.07
Edina	9,990	$27.32
Wayzata	9,577	$26.93
Vadnais Heights	9,109	$17.21
Rogers	9,100	$15.11
Maple Plain	3,540	$23.71
Watertown	3,439	$27.21
New Germany	3,255	$46.65
Greenfield	3,075	$30.34
Columbus	1,770	$10.09

Table 9 – Highest and Lowest Monthly Residential Water Bills

Municipality	Monthly Bill Volume (gallons)	Average Monthly Bill
Saint Francis	6,772	$61.76
Elko-New Market	6,107	$53.24
New Germany	3,255	$46.65
Excelsior	7,559	$41.12
Mound	4,181	$36.38
Maple Grove	8,142	$9.36
Blaine	6,983	$9.24
Lakeville	7,455	$9.14
White Bear Lake	5,596	$8.06
Woodbury	7,493	$7.63

Location of the Average Residential User in Tiered Rate Structure

One question that arose in the 2015 analysis was in which tier of a tiered rate structure was the average customer located. In the prior analysis, 8,200 gallons per month was calculated for the average residential customer and a rounded volume of 8,000 gallons per month was used to identify the tier the average customer would correspond with for each municipality with a tiered rate structure. That analysis of the metropolitan-wide average water use showed that among municipalities with tiered rate structures, a monthly volume of 8,000 gallons fell into the first tier for 31 percent of municipalities with tiered rates, fell into the second tier for 55 percent of municipalities, and fell into the third tier for 14 percent of municipalities.

This analysis was revised with updated rate and water use data. An average residential customer water use was determined for each municipal utility, rather than using metropolitan-wide average volume of use for all municipal utilities.

As shown in Table 10, the updated analysis shows that approximately 57, or 62 percent, of the 93 average monthly volumes fall into the first tier; although, 20 of these are uniform rates (i.e., there is only one tier). Of the 37 utilities with tiered rate structures that have the average monthly volume falling into Tier 1, nine have a base volume that precedes the Tier 1 volume. Of these nine, four have two tiers above the base volume, two have three tiers above the base volume, and three have more than three tiers above the base volume. The example of Bloomington highlights how the analysis works in the specific circumstance where a base volume exists in the tiered structure. Bloomington has an average volume of 7,065 gallons per month and a base volume of 2,000 gallons per month, the average residential customer use falls into Tier 1.

For 28, or 38 percent, of the 73 tiered-rate structures, the average monthly volume falls into the first tier of a tiered rate structure with no base volume preceding Tier 1. Approximately 34, or 36 percent, of the monthly volumes fall into Tier 2. Of these, three utilities have two-tiered structures (one of which has a base volume), 13 have three-tiered structures (of which two have a base volume), and 18 have rate structures with more than three tiers (one of which has a base volume).

Only 2, or 2 percent, of the monthly volumes fall into Tier 3. One of these utilities has a rate structure with three tiers and one has a rate structure with four tiers. Neither of these rate structures has a base volume.

Table 10 – Location of Average Residential Use in Tier Structure

Rate Structure	Average Residential Use is Tier 1 (number)	Average Residential Use is Tier 2 (number)	Average Residential Use is Tier 3 (number)	Total	% All	% Tiered
Uniform (1 Tier)	20	-	-	20	22%	-
2 Tiers	3	2	-	5	5%	7%
Base Vol. with 2 Tiers	4	1	-	5	5%	7%
3 Tiers	14	11	1	26	28%	36%
Base Vol. with 3 Tiers	2	2	-	4	4%	5%
3+ Tiers	11	17	1	29	31%	40%
Base Vol. with 3+ Tiers	3	1	-	4	4%	5%
Total	57	34	2	93	100%	100%

"Conservation" Rates

According to Minnesota statutes, a "conservation rate structure" is defined as a rate structure that encourages conservation and may include increasing tier rates, seasonal rates, time of use rates, individual goal rates, or excess use rates. However, general economic theory suggests that an increasing tier rate structure may not be deemed a "conservation" rate structure if the step up in rates from one tier to the next does not convey the conservation incentive, or "price signal," to the customer that would lead to a change in water use.

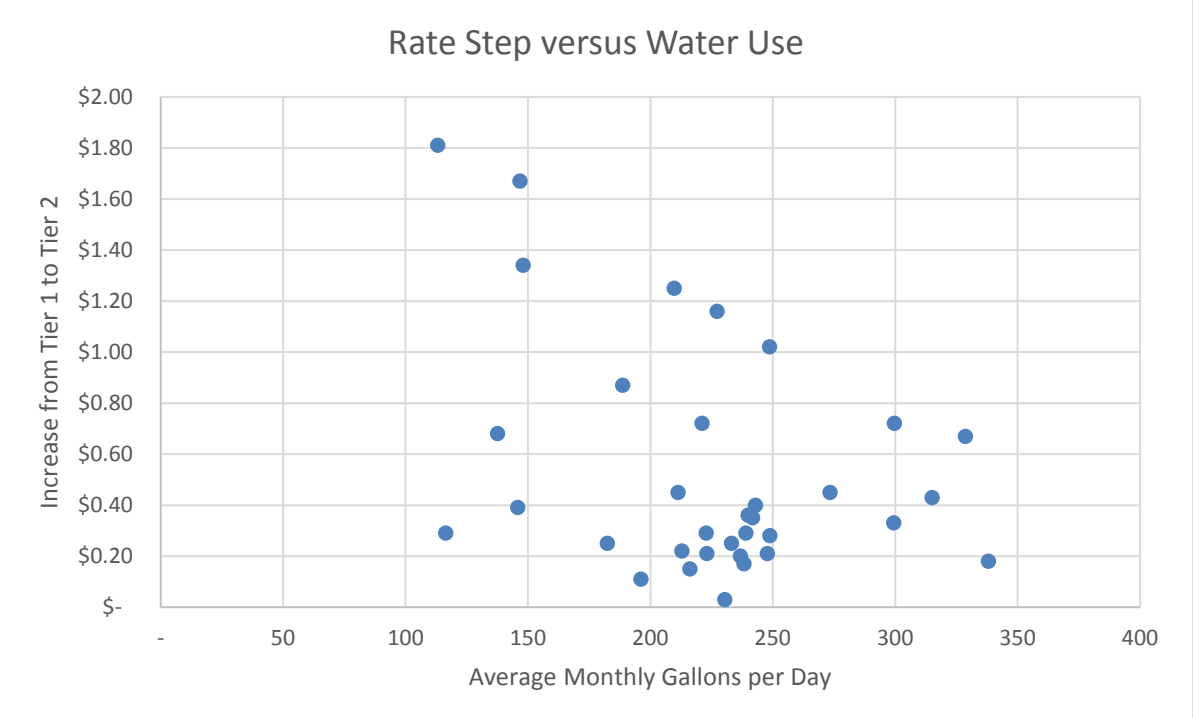
Among the 34 rates in which the average residential monthly water use falls into Tier 2, the "step" in price from Tier 1 to Tier 2 was calculated. This price step ranged from a low of $0.03 up to a high of $1.81 per 1,000 gallons, with an average increase of $0.54 per 1,000 gallons between tiers. The municipalities with the five highest and lowest steps from Tier 1 to Tier 2 are shown in Table 11.

Table 11 – Highest and Lowest Rate Changes from Tier 1 to Tier 2

Municipality	Tier 1 Rate	Tier 2 Rate	Rate Step
Watertown	$1.91	$3.72	$1.81
Belle Plaine	$3.31	$4.98	$1.67
Long Lake	$2.67	$4.01	$1.34
Spring Park	$2.50	$3.75	$1.25
Chanhassen	$1.16	$2.32	$1.16
Andover	$2.12	$2.30	$0.18
St. Anthony	$3.10	$3.27	$0.17
Hugo	$1.50	$1.65	$0.15
Mahtomedi	$2.23	$2.34	$0.11
Apple Valley	$1.24	$1.27	$0.03

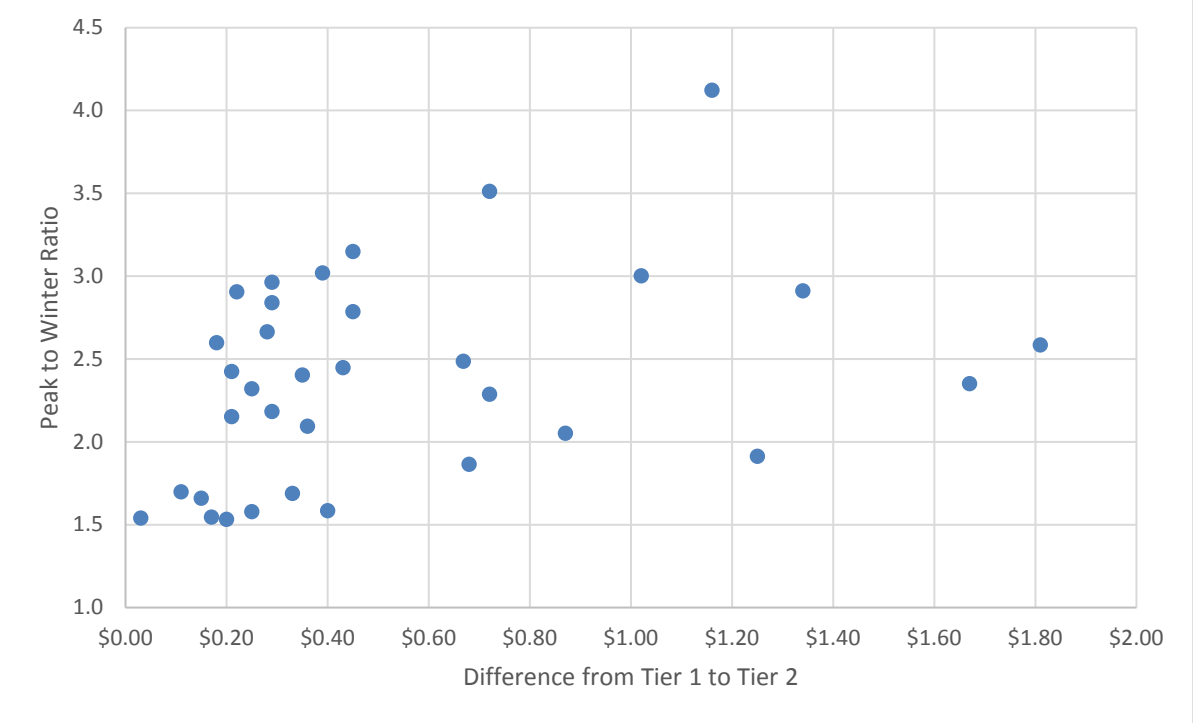
A comparison of the rate steps of these 34 municipalities versus the average residential monthly water use is illustrated as a scatter plot in Figure 6. In theory, one would expect an association of larger rate steps with lower water use (i.e., customers are getting the price signal) and smaller steps with higher water use (i.e., customers who are not getting a price signal). To some extent, this relationship can be seen in that those municipal utilities with an average monthly residential volume greater than approximately 250 gallons per day have steps less than a dollar, yet there are other municipalities with low rate steps and low water use.

Figure 6 – Rate Step versus Water Use for Municipal Utilities with Average Residential Use in Tier 2



A peak month to winter ratio using monthly water use data was developed for each municipal utility, as described below. This peak month to winter ratio was compared to the Tier 1 to Tier 2 rate step for municipal utilities in which the average residential monthly water use falls into Tier 2. A comparison of this peak month to winter ratio versus the Tier 1 to Tier 2 rate step for these 34 municipalities is shown in Figure 7. All else being equal, one would expect that municipal utilities with larger steps would have lower peak to winter water use ratios. However, such a relationship is not evident from this comparison, suggesting that factors other than the conservation rate structure are influencing the peak month water use.

Figure 7 – Rate Step versus Peak Month to Winter Ratio

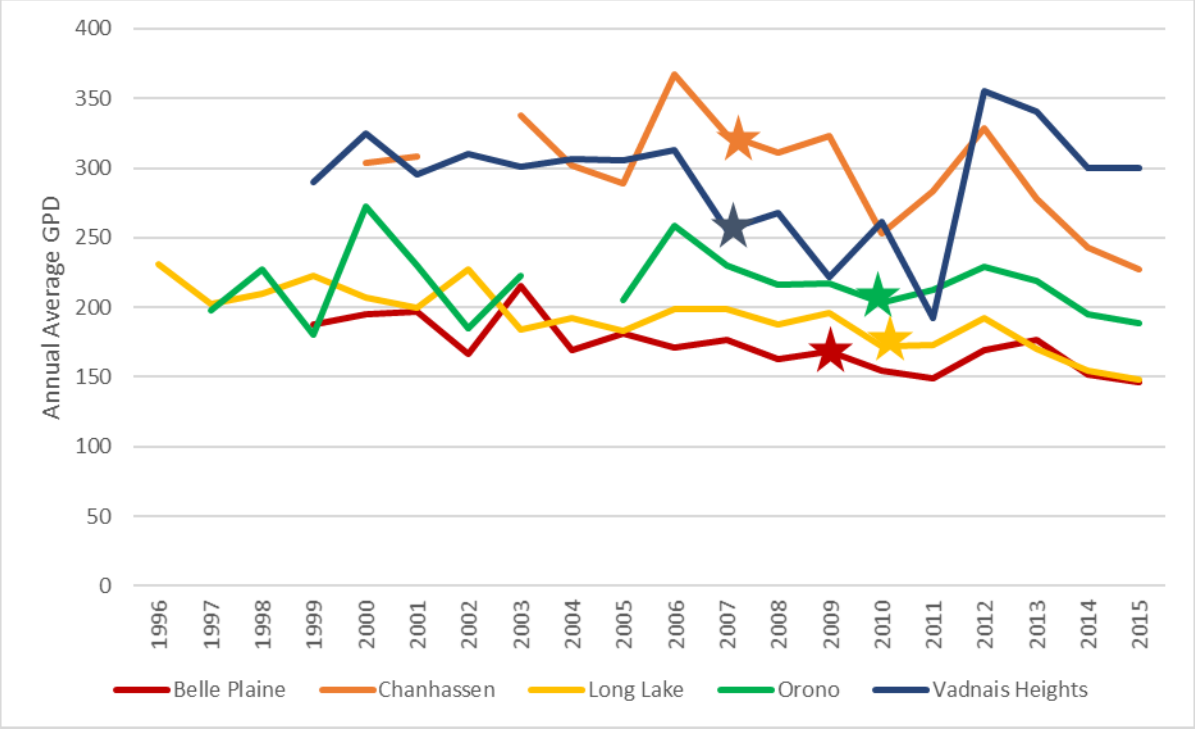


One question that was asked was whether or not a noticeable shift in water use occurs after a municipal utility implements a conservation rate. The historical annual water use for municipalities with the largest rate steps was evaluated, and the municipalities were asked when the steep conservation rates went into effect. Note that Watertown is among those with the largest step from Tier 1 to Tier 2, but the tiered rates were in effect before the time period of available water use information. The timing of conservation rates for Spring Park was not available. Thus, Vadnais Heights and Orono, which also have a large rate step, are included in the analysis. The years in which the conservation rates were enacted are shown in Table 12. The historical trends in annual water use for these municipalities are shown in Figure 8.

Table 12 – Year that Conservation Rates were Implemented

Municipality	Year in Effect
Belle Plaine	2009
Chanhassen	2007
Long Lake	2010
Orono	2010
Vadnais Heights	2007

Figure 8 – Change in Average Residential Gallons Per Day Use Before and After Implementation of Conservation Rate Structure



Belle Plaine put their conservation rates in effect in 2009. Since about 2003, their average annual demand had been on a gradual downward trend until 2012. While the rate change may have resulted in the continued downward trend in 2009 and 2011, there appear to be other factors that have influenced the downward trend prior to 2009, and resulted in higher use in 2012 and 2013.

In 2007, Chanhassen shifted from a 2-tier to a 4-tier rate structure. In general, average annual water use has been lower since that point in time.

Long Lake implemented their conservation rate structure in 2010. Overall, their annual average water use has been in a gradually decreasing trend for almost 20 years. There is a slight dip in annual average water use in 2010 and 2011 that could reflect the rate change, in addition to other factors including the overall decline in water use.

Orono also enacted their conservation rate structure in 2010. While there is a slight dip in water demand in that year, there does not seem to be strong evidence of a price influence.

Vadnais Heights implemented conservation rates in 2007 and a strong decline in demand is evident from 2007 to 2011, followed by a significant increase in water use.

As noted, there are many factors that influence overall water demand, including improved water efficiency among residential water-using fixtures (e.g., toilets, showerheads, faucets, and clothes washers). In addition, weather, demographic changes, changes in the mix of residential and non-residential customers, and water rates affect water use. This analysis does not control for, or take into account, any of these influences, yet it appears that in most instances the timing of the rate changes can be associated with declines in total annual water demand.

Another form of conservation rate structure is to have different rates for the same tier based upon the time of year. These seasonal rates include a higher rate (dollar per volume) in higher use months to encourage water use efficiency and lower the peak demand. Twenty municipalities provide seasonal water rate structures such that customers face different pricing for water in winter and summer months, as shown in Table 13. Most of these municipal utilities (80 percent) have uniform rate structures that change from a winter rate to a summer rate. Forest Lake has a 2-tiered rate structure with a $0.32 per 1,000 gallons increase in the Tier 1 rate in summer months and an increase of $1.25 per 1,000 gallons in summer in Tier 2. Victoria changes from a single uniform rate in the winter months to a 10-tier rate structure with a step of $0.29 per 1,000 gallons from Tier 1 to Tier 2 in the summer months.

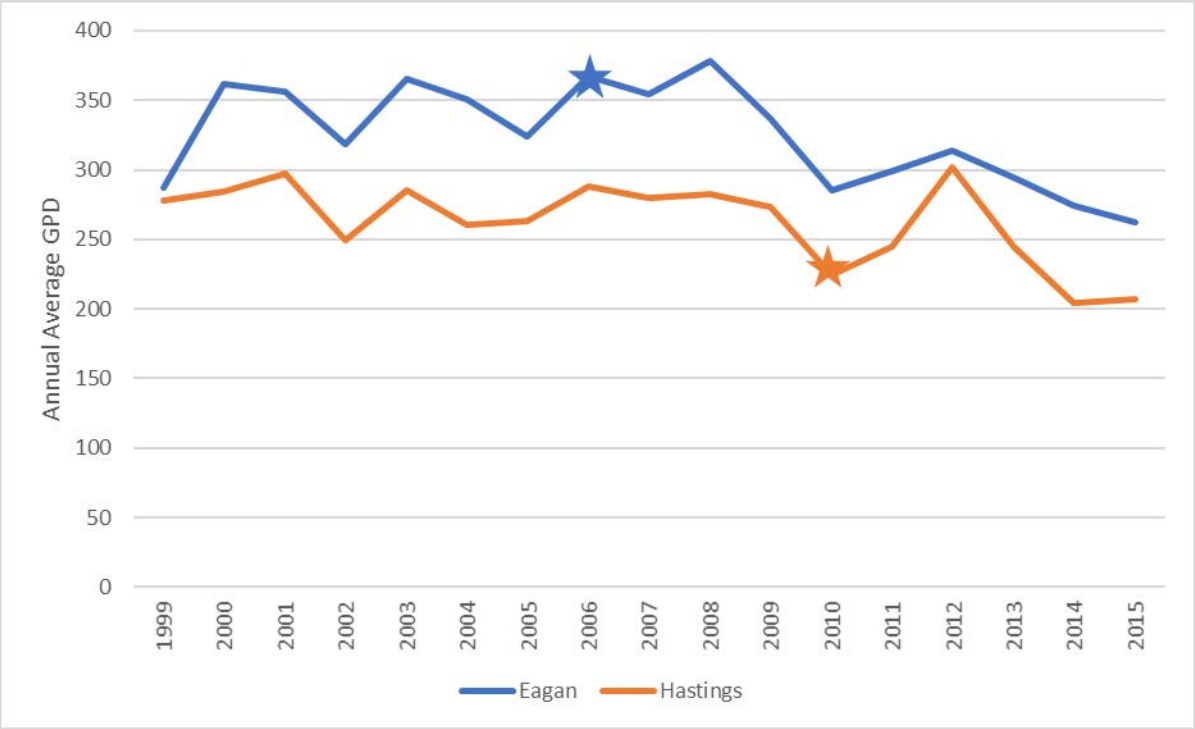
Table 13 – Seasonal Rate Structures (Tier 1 Only)

Municipality	Billing Frequency	Tier 1 Rate (Winter)	Tier 1 Rate (Summer)	Billing Unit	Structure
Birchwood Village	Quarterly	$1.05	$1.30	ccf	Uniform
Eagan	Quarterly	$1.58	$1.95	kgal	Uniform
Falcon Heights	Monthly (Residential) Quarterly (Commercial)	$2.52	$2.62	ccf	Uniform
Forest Lake	Quarterly	$3.24	$3.56	kgal	Tiered, after first 5,000 gallons
Hastings	Quarterly	$1.85	$2.35	kgal	Uniform
Lauderdale	Monthly (Residential) Quarterly (Commercial)	$2.52	$2.62	ccf	Uniform
Lilydale	Monthly/Quarterly	$3.02	$3.14	ccf	Uniform
Little Canada	Quarterly	$3.30	$3.41	kgal	Uniform
Maplewood	Monthly (Commercial) Quarterly (Residential)	$2.52	$2.62	ccf	Uniform
Mendota	Monthly (Commercial) Quarterly (Residential)	$3.02	$3.14	ccf	Uniform
Mendota Heights	Monthly (Commercial) Quarterly (Residential)	$3.02	$3.14	ccf	Uniform
Minnetonka	Commercial/Industrial Monthly	$2.50	$2.85	kgal	Uniform
Roseville	Commercial Quarterly	$2.95	$3.15	kgal	Increasing

Municipality	Billing Frequency	Tier 1 Rate (Winter)	Tier 1 Rate (Summer)	Billing Unit	Structure
South Saint Paul	Monthly (Commercial) Quarterly (Residential)	$3.02	$3.14	ccf	Uniform
Saint Paul	Monthly (Residential) Quarterly (Commercial)	$2.52	$2.62	ccf	Uniform
Stillwater	Monthly (Commercial) Quarterly (Residential)	$2.20	$2.40	kgal	Uniform, after first 10,000 gallons for
Sunfish Lake	Monthly (Commercial) Quarterly (Residential)	$3.02	$3.14	ccf	Uniform
Victoria	Quarterly	$2.81	$2.81*	kgal	Uniform in winter, *tiered in summer with 10 tiers, Tier 2 is $3.10
West Saint Paul	Monthly (Commercial) Quarterly (Residential)	$2.52	$2.62	ccf	Uniform
White Bear Lake	Quarterly	$1.05	$1.30	ccf	Uniform, rate starts after 8 cf

Historic water use was reviewed for two of these municipal utilities with respect to when the seasonal rate structures were implemented. Hastings implemented its seasonal rate structure in 2006, and Eagan implemented its seasonal rate structure in 2010. Figure 9 shows the historic annual average water use per residential connection for these two municipal utilities. Average residential water use in Eagan shows a significant decrease in water use since 2010 relative to before 2010, which suggests the new rate structure may have had its intended effect. For Hastings, the annual water use from 1999 to 2015 shows an overall gradual decline with no significant change before or after 2006, which suggests that the new rate structure may be just one of many factors influencing the average residential use over time, or may have no influence at all.

Figure 9 – Change in Average Residential Gallons Per Day Use Before and After Implementation of Seasonal Conservation Rate Structure

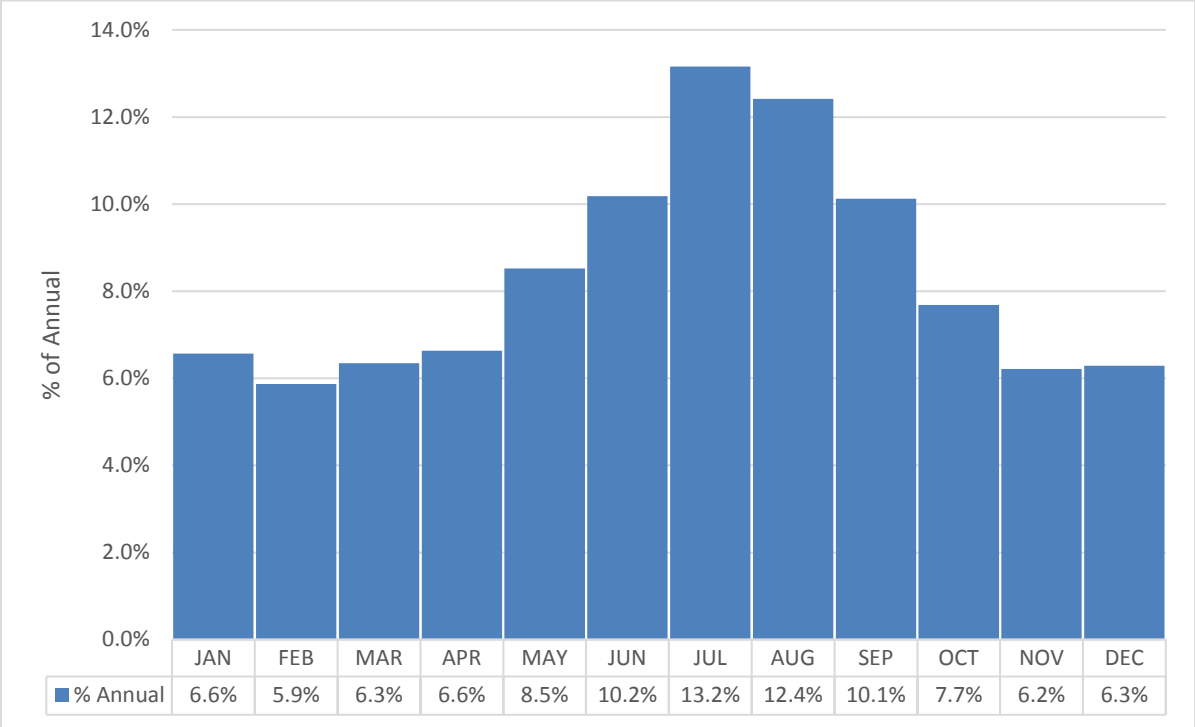


Seasonality of Water Use

MPARS monthly water use data contains the reported monthly volume by year and permittee (i.e., municipal utility). The data provided for this analysis included data from 2015 back to 1988[1]. A few municipalities had only a few years of data while most reported data for more than 20 years. For this analysis, data was used from 2000 to 2015, averaging the water use across all municipalities and years for each month, as shown in Figure 10. Note that if all 12 months used the same amount of water, each month would represent 8.3 percent of annual water use. On average, across the metropolitan region, October through April are below this theoretical average while May through September are above this average.

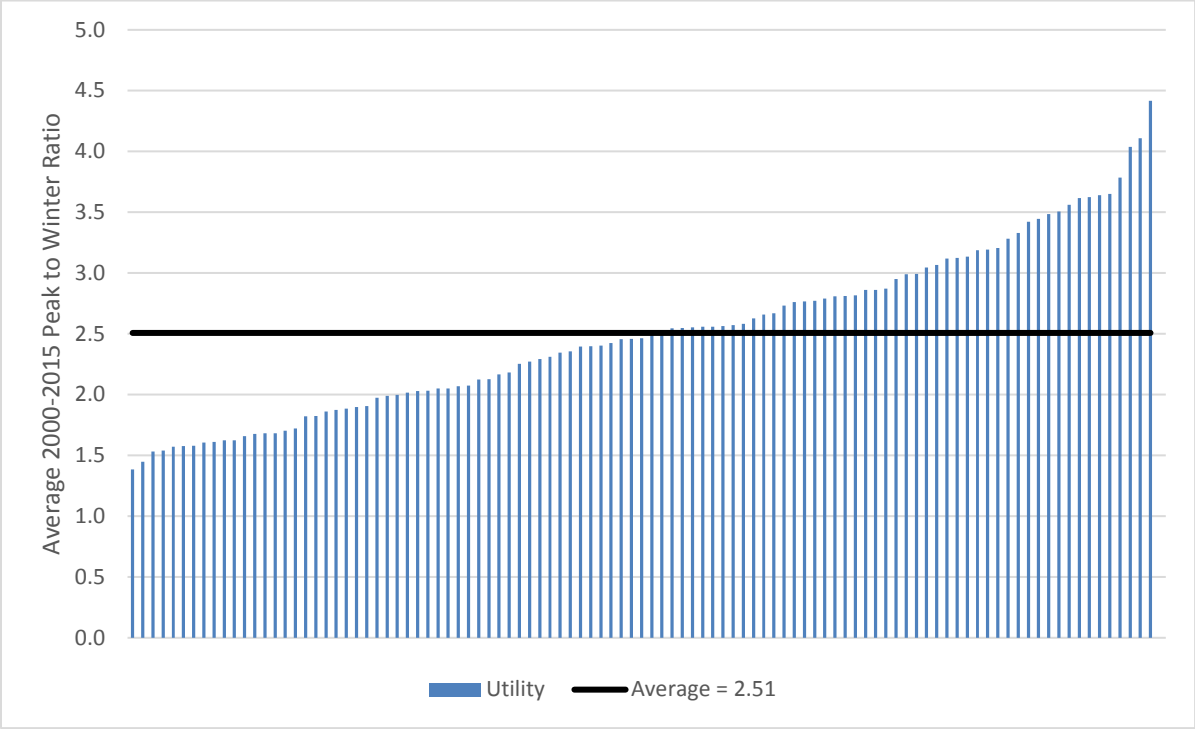
[1] MPARS reporting is not required for utilities that purchase water from other utilities.

Figure 10 – Seasonal Metropolitan Region Water Use Pattern, 2000 through 2015



Based on this information, the peak month volume of each year was divided by the winter months' volume (average of October through April) for each municipality with available data. The resulting ratios were averaged across all years for each municipality. This resulted in an average peak month-to-winter ratio for these municipal utilities as shown in Figure 11. The average peak-to-winter ratios range from 1.38 (New Brighton) to 4.4 (Andover), with an average across the utilities of 2.51.

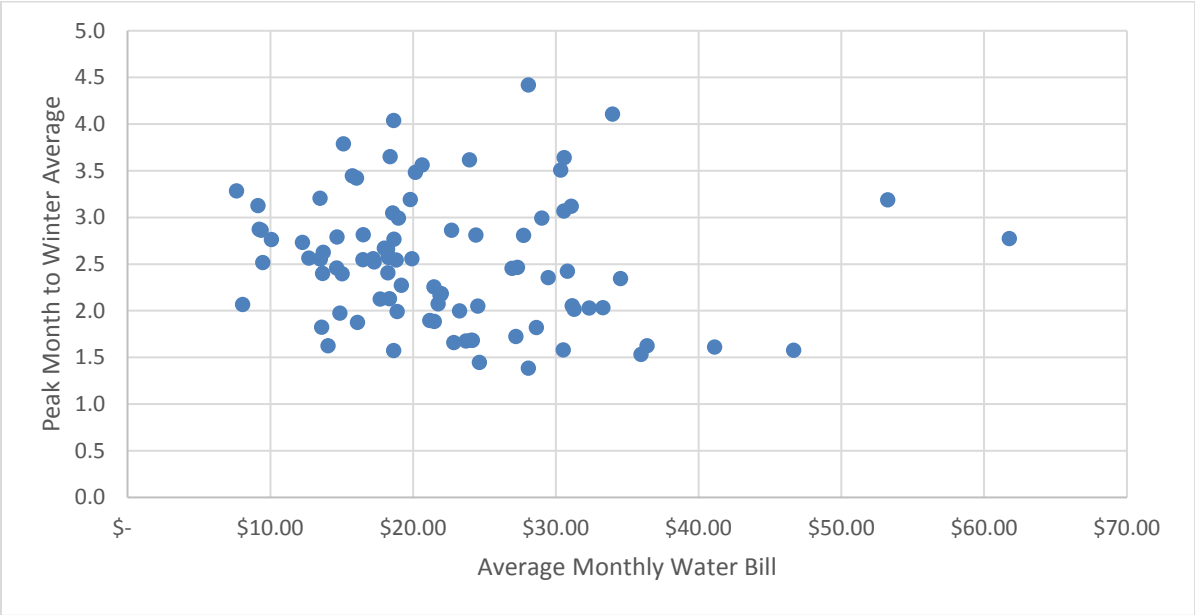
Figure 11 – Average 2000-2015 Peak to Winter Ratio by Municipal Utility



A comparison is discussed in the previous section of this peak-to-winter ratio with the rate step from Tier 1 to Tier 2. Among those 34 municipalities, there was not a significant trend between the conservation rate step and the peak-to-winter ratio.

A comparison of the peak-to-winter ratio with the equivalent monthly water bill is inconclusive as shown in Figure 12. Two municipalities with similar ratios may have widely divergent water bills. Conversely, two municipalities with similar water bills may have divergent peak-to-winter ratios.

Figure 12 – Peak to Winter Ratio and Monthly Water Bill



One question to emerge was whether or not customers with monthly water bills are more likely than customers with quarterly water bills to see the changes in their water use and bills during the summer months and therefore use less water (i.e., have lower summer to winter ratios). A comparison of the summer to winter ratio with billing frequency in Figure 13 shows little difference between monthly (12 per year), bi-monthly (6 per year), or quarterly (4 per year) billing periods. The average and range of the ratios by billing frequency are listed in Table 14. The quartiles and range of the peak-to-winter ratios for those that are billed bi-monthly are narrower than the quartiles and ranges of monthly or quarterly billing, but there are also fewer such rate structures.

Figure 13 – Peak to Winter Ratio Relative to Billing Frequency

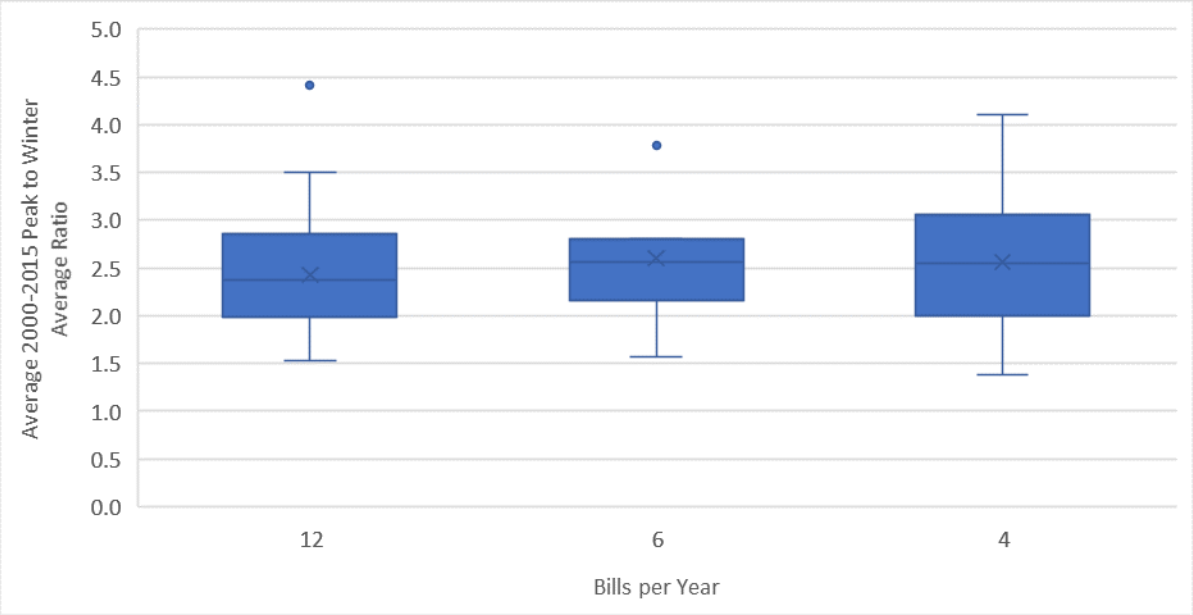


Table 14 – Ranges of Peak to Winter Ratios by Billing Frequency

Billing Frequency	Number of Utilities	Average Ratio	Minimum Ratio	Maximum Ratio
Monthly	32	2.42	1.53	4.42
Bi-Monthly	7	2.60	1.57	3.79
Quarterly	54	2.56	1.38	4.11

Municipal Water Demand and Drought

The Palmer Drought Severity Index (PDSI) is a meteorological index used to track temperature, precipitation, and soil moisture conditions as an indicator of drought. Positive PDSI values indicate wet, non-drought conditions, near zero values indicate normal conditions, and negative values indicate drought conditions. The negative PDSI values and associated drought conditions are listed in Table 15.

Table 15 – Palmer Drought Severity Index (PDSI) Scale

Value	Drought Condition
Above 0	Non-Drought
0 to -0.5	Normal
-0.5 to -1.0	Incipient Drought
-1.0 to -2.0	Mild Drought
-2.0 to -3.0	Moderate Drought
-3.0 to -4.0	Severe Drought
Below -4.0	Extreme Drought

The Metropolitan Council Region is in the Minnesota East Central Region as defined by the National Climatic Data Center (NCDC). Historic monthly PDSI values were obtained for the Minnesota East Central Region from NCDC.NOAA.gov. Total Metropolitan Council Region municipal monthly water use was obtained from the MPARS Monthly Usage file for 1988 through 2015. Figure 14 shows a comparison of the total metropolitan region monthly water use in million gallons per day (mgd) in comparison with the monthly PDSI for the period 1988 through 2015.

Figure 15 shows the same data for the period 2000 through 2015.

As noted in Table 16, a PDSI of -3.0 or less is an indicator of severe drought. Since 1988, the PDSI has dropped below -3.0 four times: all of 1988, early winter (January and February) of 1990, the winter (November through February) of 2006-2007, and the summer (June through August) of 2007. Extreme drought conditions were experienced in 1988 and 2007. Both of these summers experienced monthly waters demand in excess of 600 mgd. July of 2006 and July of 2009 had PDSI values in the moderate drought condition category and also experienced water demand in excess of 600 mgd. Therefore, 600 mgd would appear to be a threshold consistent with drought conditions. However, July of 2001, August of 2003, July and August of 2008, and July of 2012 had monthly demand near, or more than, 600 mgd without drought conditions.

Figure 14 – Metropolitan Region Monthly MGD and Palmer Drought Severity Index, 1988 through 2015

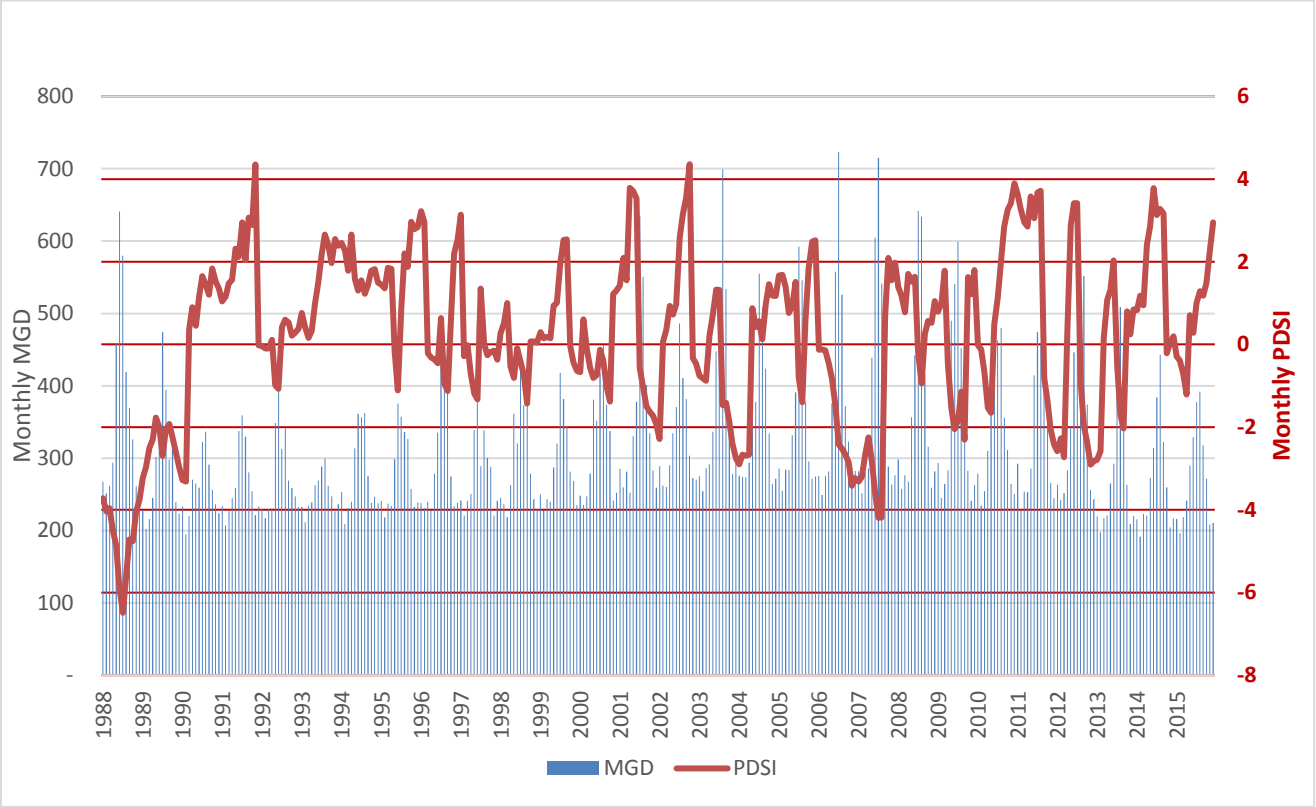
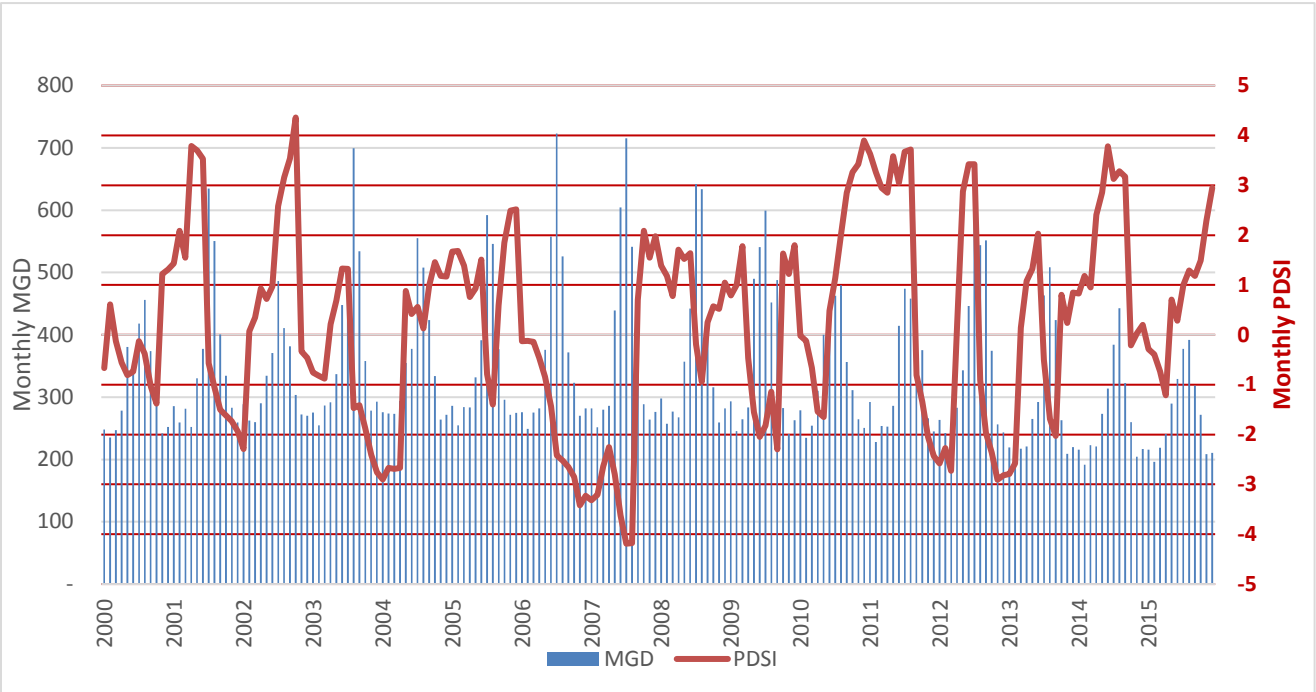


Figure 15 – Metropolitan Region Monthly MGD and Palmer Drought Severity Index, 2000 through 2015

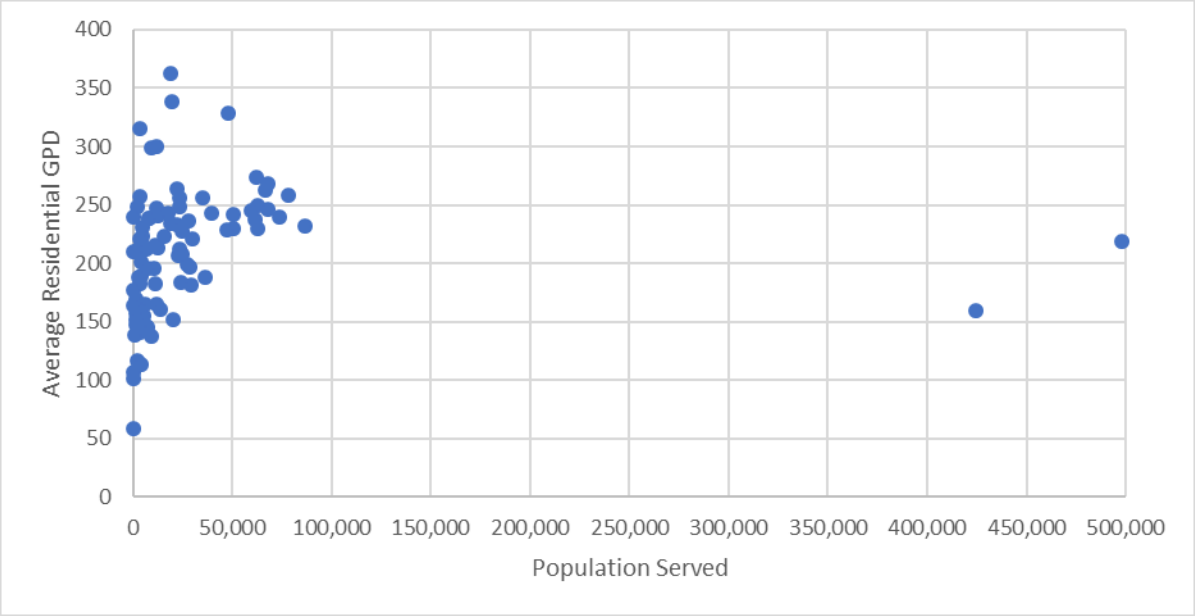


Municipal Characteristics

An analysis was conducted to determine whether there are any relationships between the characteristics of a municipality and their residential water use. Characteristics were defined as age of municipal water system, population trends (increasing, stable, decreasing), and presence of a water treatment facility.

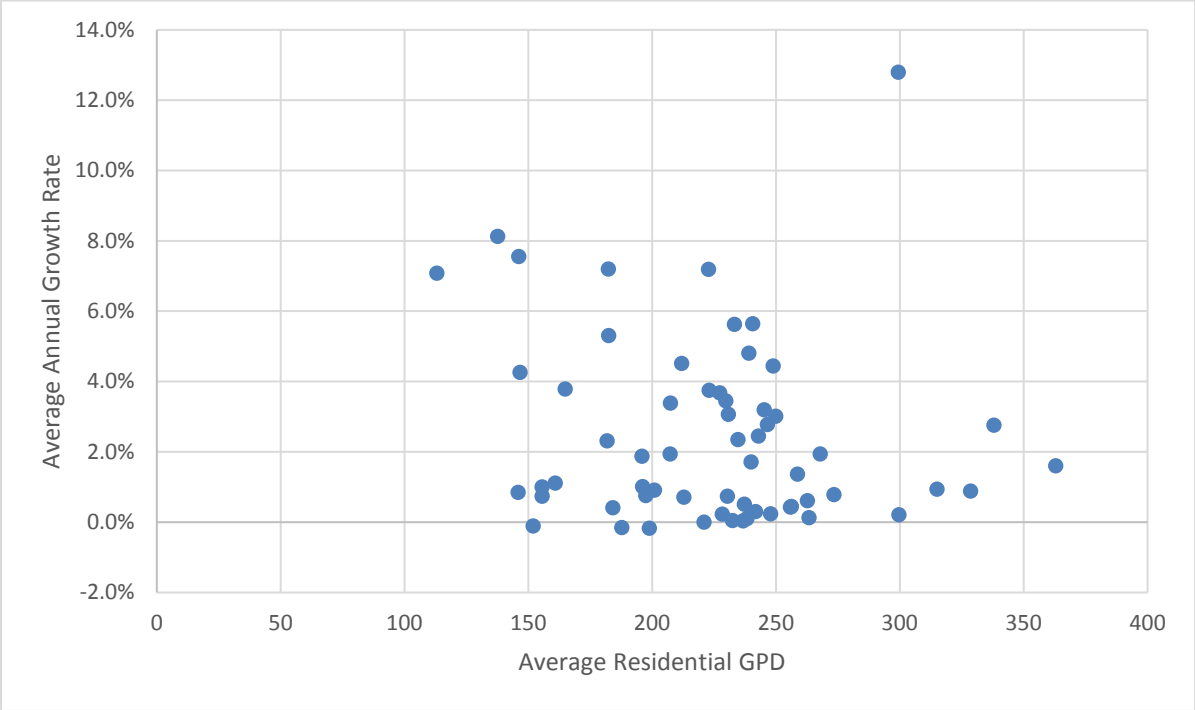
Information was available on the population served by each municipal water system. Among those municipalities for which the average residential water use (in gallons per day) could be determined, there is little correlation with the population served, as shown in Figure 16. One observation is that there is a wider variation in average use per residential customer among smaller municipal utilities with a convergence toward a range of about 230 to 270 gpd per connection among municipal utilities serving populations above 50,000.

Figure 16 – Water Use versus Population Served



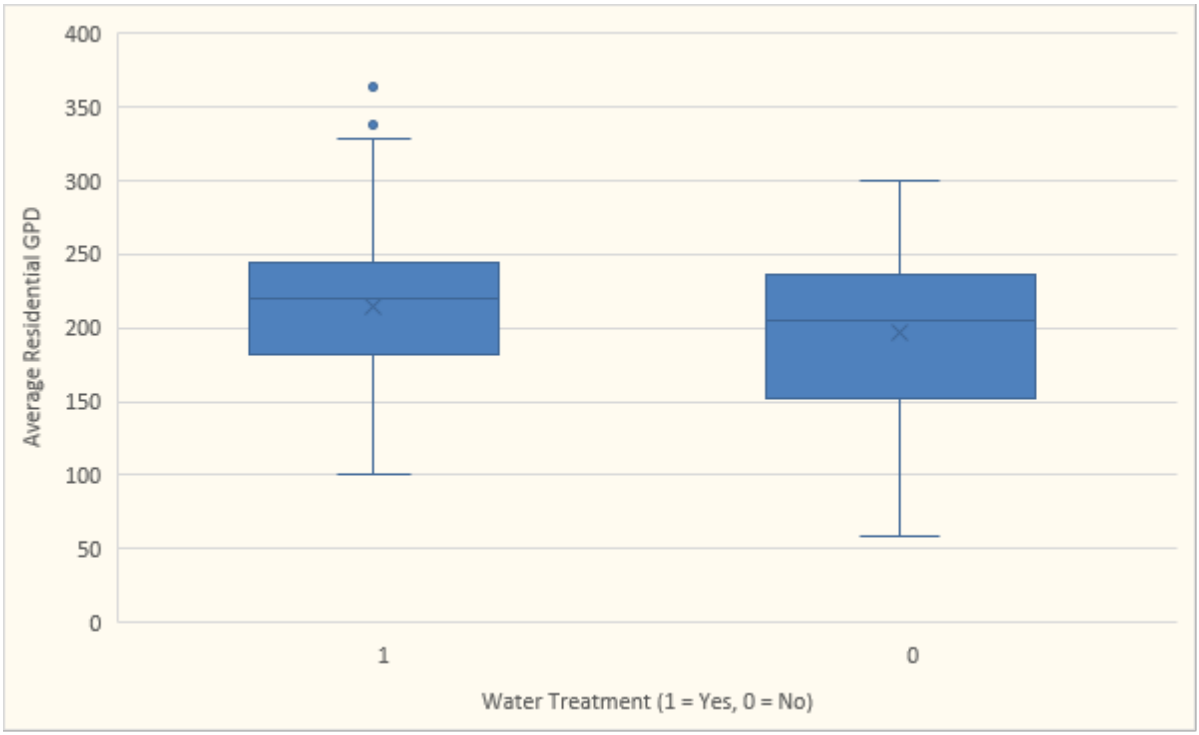
The historical trend in number of connections was used to determine if a municipal water system was growing, relatively stable, or in decline. The percent change in connections from year-to-year was averaged across all available years to derive an average growth rate for each municipality. Data were available for 63 of the municipalities. The average growth rate ranged from a -0.17 percent (Shoreview) to 12.8 percent (Rogers). No discernible pattern is evident when the average annual growth rates are compared to its average residential GPD per connection as shown in Figure 17.

Figure 17 – Water Use versus Average Annual Growth Rate



Information was available for many municipal utilities as to whether or not they treat their own water. This characteristic is indicated by a Yes or No marker indicating a treatment plant in the MDH Water Treatment Characteristics data. In general, municipalities that treat their own water (Y) tend to have a slightly higher average residential water use as shown in Figure 18.

Figure 18 – Water Use versus Treatment



The MDH Water Treatment Characteristics data contained information on the date the treatment plant began operations, and the date of the most recent treatment plant upgrade. Using the most recent of these two dates, an approximate “age of system” was calculated, where water treatment data was available. Such data was available for 70 of the municipal utilities with residential water use data, as shown in Figure 19. Less than 5 percent of these utilities have new facilities, and approximately 26 percent of these municipal utilities have treatment facilities from 5 to 10 years old. Another 23 percent are 10 to 15 years old, 13 percent are 15 to 20 years old, and 33 percent are 20 to 25 years old.

The relationship between the peak month to winter average ratio and the estimated age of the water treatment facilities is shown in Figure 20. The municipal utility with the oldest treatment system (among those for which this analysis was performed) shows one of the higher peak to winter ratios. However, there are utilities with much “younger” facilities with equal or higher ratios.

The relationship between the estimated monthly water bill and the estimated age of the water treatment facilities is shown in Figure 21. Those few utilities with water bills greater than $40 per month have treatment facilities that are 10 years old or less. However, not all utilities with treatment facilities less than 10 years old have high water bills. All utilities with treatment facilities more than 10 years old have water bills less than $40 per month.

Figure 19 – Distribution of Age of Treatment Facilities among Municipal Utilities with Water Data Available

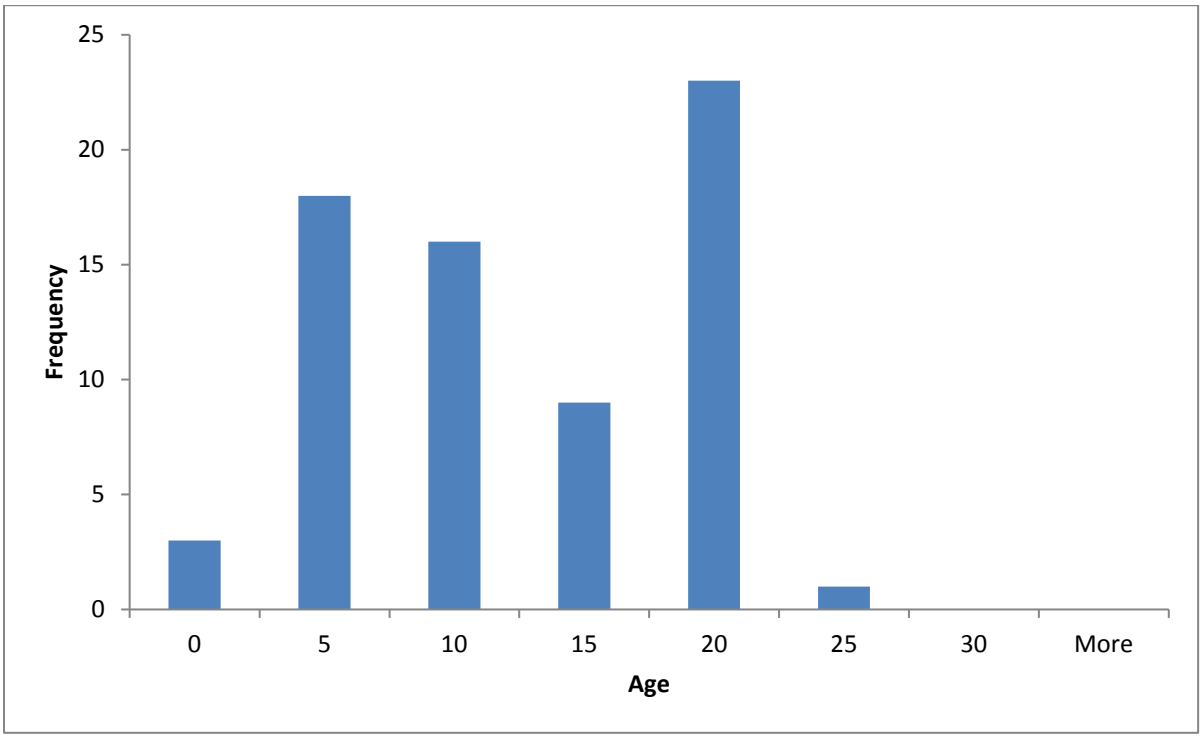


Figure 20 – Peak-to-Winter Ratio and Age of Treatment Facilities

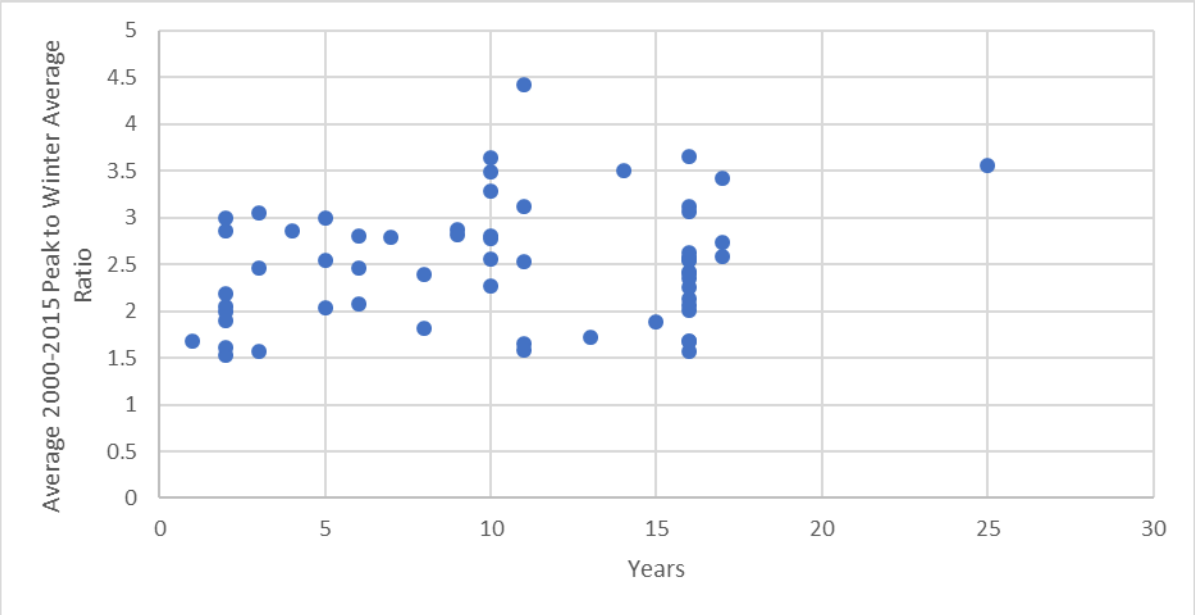
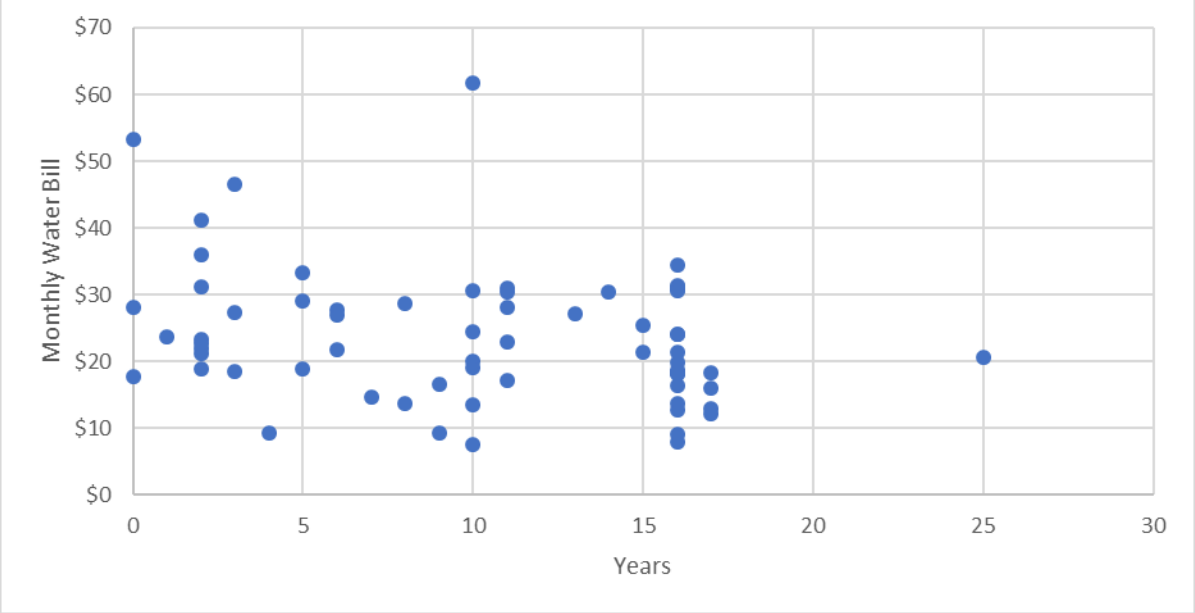


Figure 21 – Monthly Water Bill and Age of Treatment Facilities



Tools

Water Rate Look-Up Tool

The databases described above were compiled into an Access Database for the purpose of setting up queries that provide a quick look-up of the following information for each municipality:

- **Average Water Bill**: computes the average water bill for a residential customer using the average water use per billing period from the MPARS database and applying it to the rate structure for that community from the Billing Rates and Rate Structure database.
- **Customer Connections and Use**: inventories the number of connections, total volume sold, and percentage of volume sold broken down by each connection category (residential, commercial, industrial, agricultural, etc.) derived from data from the MPARS database.
- **Rate Structure**: provides detailed information including rate and volume for each tier for each municipality derived from data from the Billing Rate and Rate Structure database.
- **Utility Profile**: inventories population, water source, treatment plant design capacity, treatment plant production, total water volume sold, and maximum daily water sold derived from the data from the MPARS and the MDH Water Treatment databases.
- **Water Rates**: provides an overview of each municipality's billing rate structure as contained in a list of each customer sector, type of rate structure, number of tiers, and billing frequency derived from data from the Billing Rate and Rate Structure database.

Additional queries were developed within this database as a background for the purpose of computing the average water bill. These queries are named 1st Block Charge, 2nd Block Charge, 3rd Block Charge, 4th Block Charge, Base Charge, and Clean Utilities Values.

This database is set up to allow the Metropolitan Council to link to their website to create an interactive look-up tool that anyone in the metropolitan region can access. Note that the additional queries listed above should operate in the background and not be used in an output report. Additionally, the Metropolitan Council may opt to not list all data in each query if there are limits on the number of fields that may be displayed in a web-based query report.

Bill Tabulation Assessment Tool

As part of the overall effort on behalf of the Metropolitan Council, CDM Smith also developed a bill analysis tool tailored to developing water rate structures designed to encourage efficient use of water by residential customers. The tool is designed for use by the financial and rate development staff at the utilities.

The tool serves two purposes. First, it provides general questions and issues to consider before pursuing a residential water conservation rate structure. Second, it provides the opportunity to experiment with different rates (tier points and unit rates) based on a utility's residential billing data. By using Microsoft Excel's built-in Scenario Manager tool, utility staff can save the inputs and outputs of different rate structures for future reference and comparison purposes.

The tool was developed by first looking at who is typically targeted when setting water conservation rate structures. The residential customer class is most likely to have summer discretionary water use. Therefore, water efficiency rate structures are typically designed for this customer class. While commercial customers may have some discretionary water use in the summer, their water use may be more driven by manufacturing or seasonal business cycles. Similarly, industrial customers' water use is mostly, if not completely, driven by their core business. For example, an ice manufacturing company's water use will increase in the summer due to increased demand for its product in the summer. These

are not discretionary uses of water that can or should be curtailed. Therefore, this tool focuses on developing rate structures to encourage the efficient use of water within the residential customer class.

When designing conservation-oriented water rate structures that include a penalty tier, the design process may include an adjustment for the price elasticity of demand[2]. Trying to account for the price elasticity of demand is very complex and beyond the focus of an introductory tool. Therefore, including a price elasticity of demand element is not appropriate for this tool.

The resulting tool includes an overview, a five-step process culminating in the bill/rate structure analysis, and a link to additional resources.

- Step 1 – Establish Residential Water Efficiency Goals
- Step 2 – Define Challenges and Likely Causes
- Step 3 – Assess Whether Residential Tier Rates Can Be Implemented
- Step 4 – Prepare Residential Billing Data
- Step 5 – Conduct Tier Use Analysis

Instructions for how to use this Tool are contained in Appendix D.

Case Studies

CDM Smith investigated two non-Minnesota water utilities that have undertaken major changes in their water billing rate structures. These are:

- Denver, Colorado
- Louisville Water Company, Kentucky

The following information was requested from these utilities:

1. Reason for the change in rate structure;
2. Year implemented;
3. Cost to implement (if available);
4. Rate structures considered;
5. Rate structures selected, and why;
6. Major hurdles; and,
7. Lessons learned.

The information obtained is provided in a case study format in Appendix E.

Rate Assessment Workshop

Water conservation is a growing issue that requires utility managers to rethink their rates and their rate structures in the face of environmental and regulatory influences. At the same time, utility managers face decreasing revenues in an era of ever increasing efficiency in plumbing fixtures while costs

[2] Price Elasticity of Demand is defined as the responsiveness between a change in demand and the change in price. An elastic demand occurs if a small change in price causes a large change in demand. An inelastic demand occurs if a large change in price causes a small change in demand.

continue to increase. For this reason, a rate assessment workshop was organized to provide information on how to evaluate existing or proposed rate structures in terms of balancing the need to generate sufficient revenue to cover costs with encouraging greater water efficiency.

The Rate Assessment Workshop was conducted on December 7, 2016 at the Shoreview Community Center. The session was organized for a target audience of financial and non-financial utility managers who are interested in learning more about establishing tiered rate structures that encourage water efficiency. The following outline details the information presented at the workshop:

1. *Water Utility Rates Overview*
    a. *Utility governance structures in the U.S.*
    b. *Most common methods to fund utilities*
    c. *Three basic elements of a cost of service study*
    d. *Revenue requirements*
    e. *Cost of service allocation*
2. *Anatomy of Utility Costs*
    a. *Why isn't water free?*
    b. *Costs that change with the amount of water delivered*
    c. *Costs that don't change with the amount of water delivered*
    d. *Water is a capital intensive commodity*
    e. *Dissecting rate structures (what recovers what costs)*
    f. *How can I ensure I recover costs to serve my customers from rate revenue?*
3. *Designing Rates to Influence Customer Behavior*
    a. *Common reasons to direct use behavior*
    b. *Availability and quality of data*
    c. *Customer diversity*
    d. *Seasonality of revenues and costs*
    e. *Rate structure considerations*
    f. *What do you think of your communities?*
    g. *Weather risks*
    h. *Implementing an alternative*
4. *Application of Subject Matter to Two Example Utilities (fictional)*

The lead instructor was Ann Casey, a CDM Smith financial project manager experienced in working with management, administrative, and financial aspects of utilities and municipalities, including water, wastewater, electric, and gas utilities. Her comprehensive experience includes business process review, performance management development, financial planning, asset management, due diligence, feasibility studies, policy studies, capital improvement financing projects, rate studies, bond feasibility studies, and operation and staffing studies. Ann received her BSBA in Finance from Loyola University and her MBA in Finance from Rockhurst University.

The number of attendees totaled 67, representing a wide cross-section of water utility responsibilities. These included public works directors, finance managers, city administrators, project engineers, water board members, and water resource staff. Four Professional Development Hours (PDH) credits were

offered to attendees through CDM Smith University. Eighteen (18) attendees took advantage of the opportunities to receive these credits.

Appendix F contains the announcement, agenda, and materials provided for the workshop.

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