City of Grand Prairie
Residential Water Meter Reading Audit

April 2016

TO: **Ron McCuller, Director of Public Works**

FROM: **Cathy Patrick, Management Services Director**

DATE: **April 1, 2016**

RE: **Residential Water Meter Reading Audit**

Management Services has completed a review of the City's residential water meter reading program. We utilized the following methodology in the performance of this audit; observed staff functions, including manual and AMR meter readings, completion of work orders and customer phone calls, examined manual and system generated meter reading and work order related data, performed validity and verification testing of sample equipment to ensure conformance, conducted parallel meter reading tests, recalculated monthly billings, 3rd party independent meter testing, and performed analytical procedures.

The objective was to determine if the water meter equipment including the Automated Meter Reading (AMR) system was negatively impacting customer billing, what was the magnitude of billing errors if there were any, and what factors could explain perceived billing errors.

Overall, we found controls to be generally adequate to ensure timely and accurate meter reading. 50 meters were randomly selected from the Peninsula area and sent to an independent 3rd party meter testing facility for verification of metering accuracy. Of the 50 meters tested, only one meter fell outside the accuracy limits for compliance. The meter was reading "slow" by approximately 4.7% below AWWA industry standards and thus under reading the actual amount of water flowing through it.

Based on the aggregate testing data the projected total meter error for 2015 residential volumes was an under billing of approximately 3.4 million gallons out of a total of 4.88 billion residential volume sold. The loss in revenue based on 2014/2015 budget year weighted average of residential customers in each tier was $15,134.81 out of total residential water billing of $26,760,579.

These findings and related information are discussed in the detailed audit findings sections of this report.

We would like to thank the Public Works department for their cooperation in performing this review. If you have any questions or concerns regarding this audit, please feel free to contact me at 972-237-8253.

C: Anna Doll, Deputy City Manager

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Executive Summary

A. Background

The Management Services Department conducted an audit of the water meter reading process. During the summer of 2015 the City's Public Works Customer Service Division saw a sharp increase for request for investigations because of high bill complaints in the Peninsula area in the south sector of the City. This included a petition to the Mayor from a resident which was submitted during the November 17, 2015 City Council meeting.

We believe the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

B. Object and Scope

The objective of this audit was to:

- **Determine if the water meter equipment including the Automated Meter Reading (AMR) system is negatively impacting customer billing.**
- **What is the magnitude of billing errors?**
- **What factors could explain perceived billing errors?**

The scope is from the Calendar Year 2010 through 2015.

C. Audit Approach and What We Found

The audit was conducted with a focus on the following items:

- **City's rate ordinance**
- **Recalculation of water bills**
- **Consumption data collection process**
- **Utility billing process**
- **Metering equipment accuracy**
- **Analytical data regarding Citywide and Peninsula specific water usage**
- **Factors affecting water usage in the summer months**
- **The overall magnitude of any discrepancies to the accuracy of billing**

Overall, we found controls to be generally adequate to ensure timely and accurate meter reading. 50 meters were randomly selected from the Peninsula area and sent to an independent 3rd party meter testing facility for verification of metering accuracy. Accuracy limits are established to ensure that water meters record as accurately as possible. According to industry standards, meters have an inherent variation of 2 to 3 percent in registration over the entire range of flows, except very low flows just above those that the meter will not register. Of the 50 meters tested, only one meter fell outside the accuracy limits for compliance. The meter was reading "slow" by approximately 4.7%

below AWWA industry standards and thus under reading the actual amount of water flowing through it. To put this in perspective, if a customer had an average billed consumption of 7,000 gallons a month, the customer would have actually used 7,324 gallons. Over the course of a year, this would amount to a total under billing of 3,889 gallons.

Weather variability has significant impacts on water and wastewater utility in many ways. Factors such as rainfall and temperature impact water use and the perception of use to actual usage.

Citywide and Peninsula specific usage history for the past five years are consistent with reading seen during the same billing periods in the previous years at these locations when the weather was dry.

These findings and related information are discussed in the detailed audit findings sections of this report.

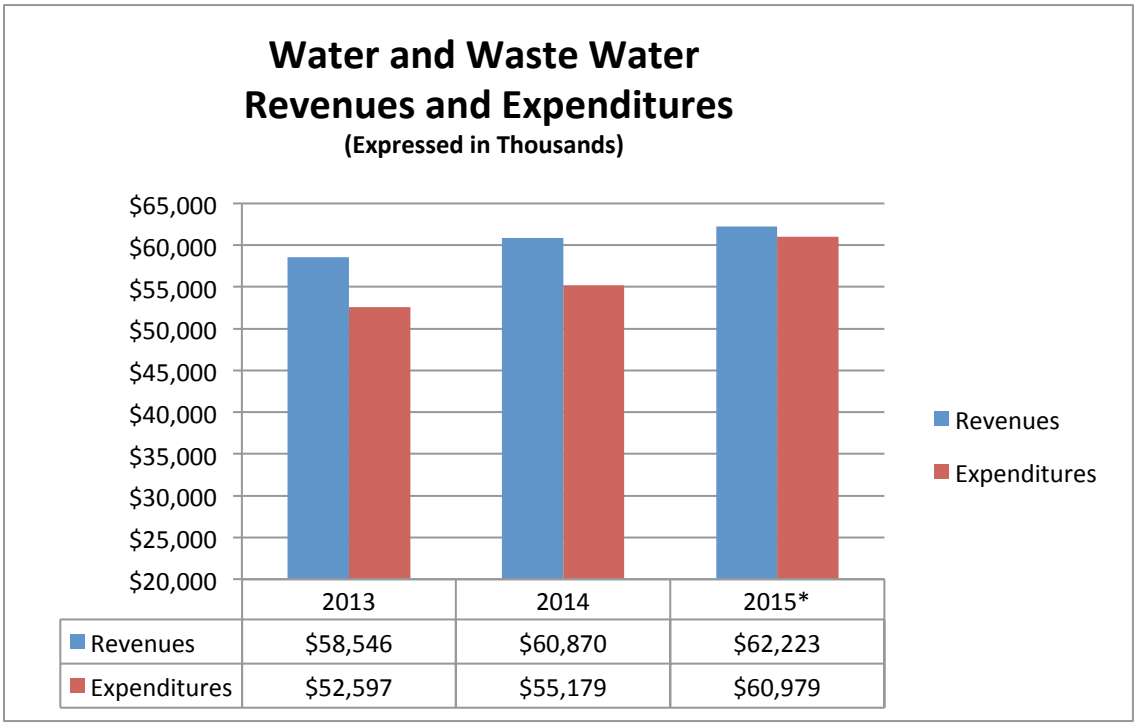
Background

The City of Grand Prairie Public Works Department maintains almost 50,000 water meters throughout its service area. The department supplies drinking and wastewater services to the entire city of Grand Prairie which spans 81 square miles, four counties and approximately 180,000 people. The department maintains and services the meters and manages meter reading, billing, and collection. Wastewater services are not provided for residents with septic systems and irrigation only accounts.

Water customer account totals are listed in the table below:

Water Customers	
	FY 2015
Residential	**45,547**
Commercial	**3,581**
Industrial	**199**
Governmental	**522**

Water and Waste Water revenues and expenditures for FY13 through FY15 are presented below:



	2013	2014	2015*
Revenues	$58,546	$60,870	$62,223
Expenditures	$52,597	$55,179	$60,979

*** Projected numbers**
Source: City of Grand Prairie Budget Office

Water Sources

The City is a blended system – combining water from a number of sources. The City's drinking water is obtained from both surface and ground water sources. In a typical year, almost 90% of water is

purchased from the City of Dallas; an additional 8% is purchased from the City of Fort Worth; and the remaining 2% is purchased from the City of Midlothian. During period of extreme water demand, water can also be produced from water wells located in Grand Prairie.

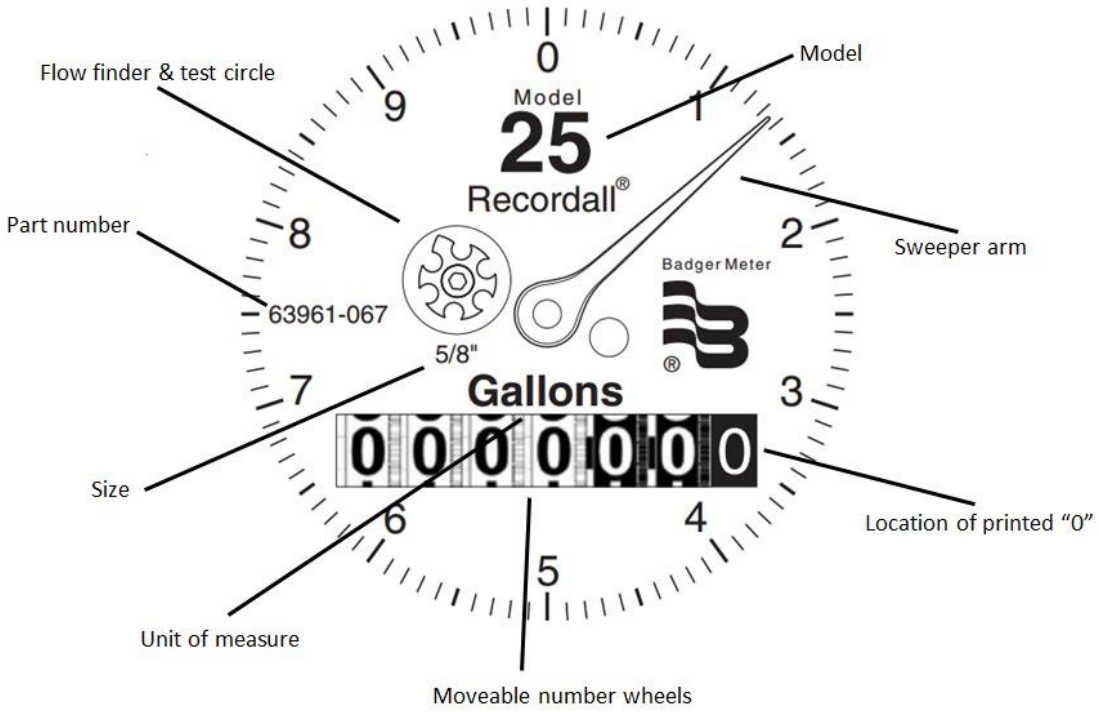
Dallas treats and uses surface water from six sources: the Elm Fork of the Trinity River, and lakes Grapevine, Lewisville, Ray Hubbard, Ray Roberts and Tawakoni.

Fort Worth's drinking water sources include: lakes Benbrook, Bridgeport, Eagle Mountain and Worth, and the Cedar Creek and Richland-Chambers reservoirs. Midlothian's surface water source is primarily from Joe Pool Lake.

The smallest portion of Grand Prairie's supply comes from ten water wells scattered throughout the City. Each well is nearly 2,000 feet deep and draws water from a formation known as the Trinity Sands aquifer.

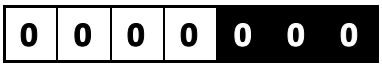
Water Meter and Register

The water meter measures the volume of water which customers use. The City utilizes Badger Model 25 (along with a small percentage of AMCO) positive displacement water meters with nutating disc technology for 5/8"x 3/4" residential installations. The water usage is recorded on an attached register with a straight-reading (left to right), odometer type totalization display in gallons. All residential water meters consist of a meter and register. Badger Model 25 markings consist of:



Water usage readings are taken from dials that look like this:

On some meters, the last three digits are white with a black background:



They represent gallons of water.

Millions	hundred thousands	ten thousands	thousands	hundreds	tens	singles

The dial works just like the odometer of a car. The dial changes only when the dial to its right turns back over to 0. The 'singles' digit is stationary because it is represented by the red "sweeper arm." Readings recorded in the system as well as on the customer's bill are in thousands of gallons, so they do not include hundreds, tens, or singles digits.

Examples:

January 21st read: 0 0 1 0 5 4 0

February 21st read: 0 0 1 0 9 8 0

This customer would be billed 0 gallons of consumption because the thousands digit has not changed.

January 21st read: 0 0 1 1 5 4 0

February 21st read: 0 0 1 9 9 2 0

This customer would be billed 8 thousand gallons of consumption because the thousands digit increased by 8.

Since the hundred, ten, and single digits are truncated, a customer consuming nearly the same amount of water could possibly have a billing difference of up to 2 thousand gallons from month to month.

Example:

May 1st read: 0 0 1 3 0 0 0

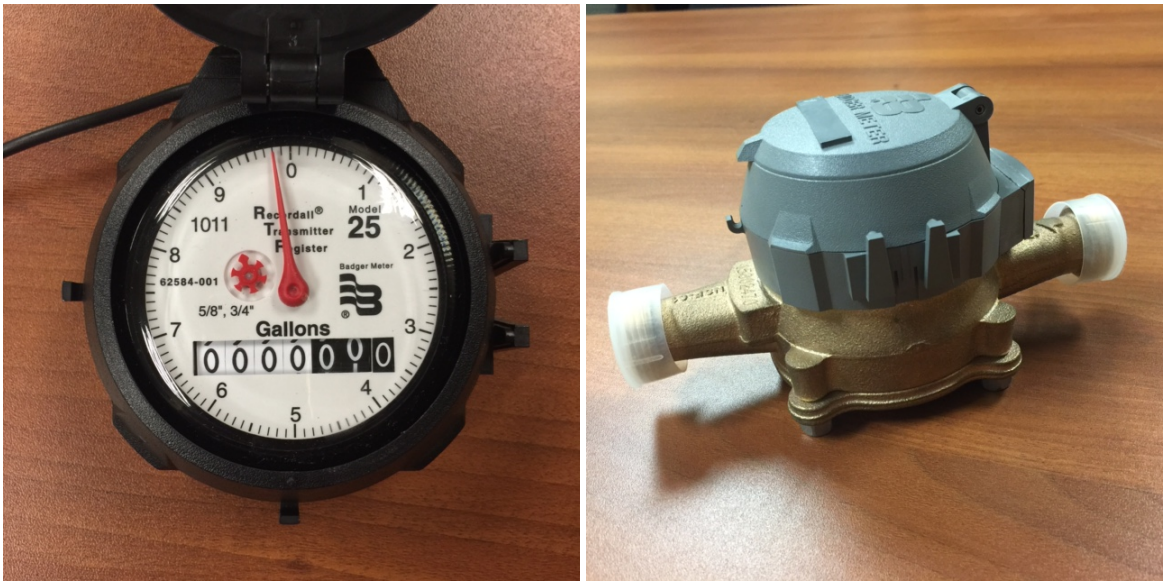
June 1st read: 0 0 1 3 9 9 9

This customer would be billed 0 gallons of consumption for the May billing cycle even though they consumed 999 gallons.

June 1st read:	**0**	**0**	**1**	**3**	**9**	**9**	**9**
July 1st read:	**0**	**0**	**1**	**5**	**0**	**0**	**0**

In June, the customer would be billed 2 thousand gallons of consumption even though they consumed 1001 gallons (a difference of only 2 gallons of additional usage from the previous month of May).

The design of the permanently sealed magnetic drive register eliminates dirt, tampering and includes a flow finder to detect leaks. Register gearing is made of self-lubricating engineered polymer, which minimizes friction and provides long life.



Left is a picture of a register with the red "sweeper arm" almost completing a full 360° rotation which will cause the tens digit to register 10 gallons of consumption. On the Right is a standard residential water meter with register attached (meters come mated with registers directly from Badger).

Meter Reading

A resident is billed for water and sewer services based on their metered usage. The City has 20 billing cycles consisting of week day meter readings and billings. The residential meters assigned to each billing cycle are divided into routes that meter readers read, either manually or with mobile automated technology.

Information captured during meter reading provides the basis for the department's water and sewer billing collection.

Meter readings can be collected via:

- **manually inspecting and reading each meter**

- automatic meter reading (AMR)
- advanced metering infrastructure (AMI)

The reading process for manual and AMR reads is relatively straight-forward, and follows a series of relatively simple steps. First the account information is retrieved from the City's customer account listing within Sungard Naviline, the City's water billing software. Next the account information is transferred in batch form to MV-RS, the City's meter reading system. This software takes the account information and reconfigures it so that it can be uploaded to electronic handheld devices, Itron Field Collector 300 (FC300), or the mobile data collectors in the vehicles.

The meter reader then takes the loaded FC300 or mobile data collector vehicle and obtains the meter readings. The process described is carried out on a daily basis, with meter reading data transferred to the department daily. The number of accounts loaded into the FC300 handheld device or mobile data collector will vary based on the route and type of meter.

Manual Meter Reading

Approximately 28% or about 14,000 meters are manually read, which are recorded by physically removing the meter box lid, visually inspecting the register, and keypunching the reading into a FC300 handheld device.

Left is a picture of an unlocked water meter box which houses the water meter and register. It must be located and unlocked with a meter box key for manual reads. On the Right, an uncovered meter box reveals the register dials which are read and the water usage is manually keyed into an electronic handheld device.

Automatic Meter Reading (AMR)

For portions of the City which have been converted to mobile AMR technology, meter readers drive scheduled routes to obtain radio reads that are automatically uploaded into mobile data collectors. For routes which may have a mix of manual reads and AMR meters, meter readers will use the FC300 handheld to obtain radio reads. For FC300 AMR readings, the meter reader will walk by the AMR enabled meter and will receive a beep indicating the wireless register reading has been obtained. After the day's routes are completed, meter readings are downloaded into MV-RS and then usage data is transferred to Naviline.

Left is a picture of the FC300 electronic handheld device. On the Right, FC300s in their docking cradle to download daily AMR and manual reads into MV-RS.

AMR meters transmit usage data through a wireless radio frequency signal. The department began installing AMR in 2003 to streamline meter reading, reduce reliance on estimated readings, and improve accuracy. Through 2015, the department had installed about 35,700 AMR meters. This represents a little more than 71% of the approximately 50,000 meters in its water system.

AMR meters offer an accurate, affordable way to measure water usage. While traditional meters must be read and inspected visually each month, usage data from AMR meters can be downloaded automatically through the mobile data collector or FC300 handheld devices.

Left is a picture of the mobile data collector laptop in its docking station which is used in a departmental vehicle on mobile read billing cycle days. On the Right, an output screen for a mobile data collector showing the route and available AMR meter readings to be collected.

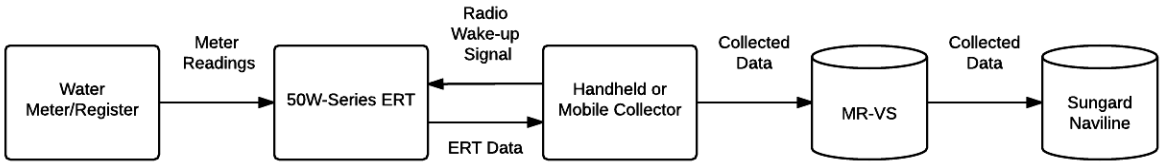
The brief wireless signals from AMR meters have much lower power density than emissions from Wi-Fi, cellular phones or other common radio frequency sources. The meters operate at energy levels that are less than 1/100 of 1 percent of the exposure limit specified by the Federal Communication Commission.

A meter interface unit also known as an Encoder/Receiver/Transmitter (ERT) module is attached to the water meter and collects water use data from the register. Using radio frequency signals, the ERT electronically transmits the data to either a handheld device or mobile data collector. The ERT is used to transmit data from utility meters over a short range so a handheld device or utility vehicle with a mobile data collector can collect meter data without a worker physically inspecting each meter. This information is then transferred to Naviline from the MV-RS system. As part of the AMR rollout, the department has installed mainly Itron 50W and 60W-series ERTs, with some 100W modules where older/damaged ERTs had to be replaced. The majority of 50W-series ERTs is end-of-life and will need to be replaced as they fail to transmit data.

Left is a picture of an Itron 50W-series ERT module and on the Right are Itron 60W-series and 100W-series ERT modules.

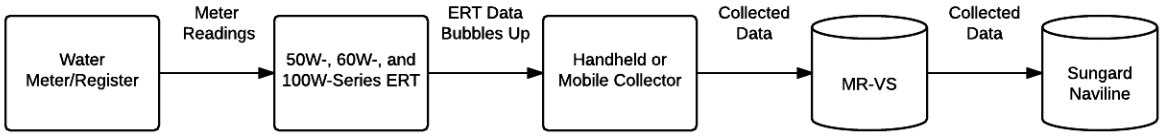
AMR ERT modules operate in two basic modes: wake-up and bubble-up. Battery life varies depending on the operating mode. In wake-up mode, the ERT module transmits the reading only when it receives a "wake up" signal from a reading device that is within RF range. Typically, this is a handheld device or mobile reading device. This approach conserves battery power, since the device only transmits when the meter reading device is within range of the unit. Sending a wake-up signal does require a license with the Federal Communications Commission (FCC). Both wake-up and bubble-up mode is available only to the Itron 50W-series ERTs.

Exhibit 1. Automatic Meter Reading in Wake-Up Mode



In bubble-up mode, the meter reading is transmitted continuously within the unlicensed 902 to 928 MHz band. The advantage to this approach is that an FCC license is not required. This approach is optimally used in AMI systems for daily and hourly readings. However, bubble-up mode can also be used for AMR meter data collection solutions. To support mobile AMR, where the vehicle drives at normal speeds, the meter reading is transmitted every few seconds. These more frequent transmissions shorten battery life. In a mobile collection environment, it is often recommended to drive at a slower speed when collecting meter data from the 60W and 100W ERT module. The meter reader team leader noted for mobile collections the vehicle normally does not exceed 15mph.

Exhibit 2. Automatic Meter Reading in Bubble-Up Mode



Currently the department utilizes a mix of wake-up and bubble-up reading modes.

Battery Life Expectations in Wake-up vs. Bubble-Up Mode				
ERT Series	**50W-Series**	**50W-Series**	**60W-Series**	**100W-Series**
Reading Mode	**Wake-up**	**Bubble-Up**	**Bubble-Up**	**Bubble-Up**
Avg. Est. Battery Life (yr)	**31.71**	**13.95**	**20.32**	**23.52**

Advanced Metering Infrastructure (AMI)

As part of its ongoing pursuit of improvements, the City regularly pursues ambitious customer service and operational efficiency goals. The metering and meter reading industry are creating greatly expanded capabilities at the customer end point and this new functionality is under Advanced Metering Infrastructure (AMI). AMI includes all the functionality of AMR, but includes functions such as backflow detection, tamper detection, and more end-point capabilities.

The purposes of the AMI implementation project are:

- **To reduce meter reading, billing and customer service operating expenses**
- **To improve the quality of customer service**
- **To provide enhanced water conservation capabilities**
- **To improve read percentages and accuracy**
- **To increase revenue generation by replacing old under-registering meters.**

The City intends to deploy AMI in five geographic oriented phases. Phase 1 of the fixed network system began in early 2016 with a tentative 3 to 5 year project completion date. The AMI upgrade includes the following:

- **Two-way communication to the 100W+ ERT endpoint for accurate GPS time synchronization and on request reads**
- **Automatic data logging in the endpoint – accurate, reliable hourly consumption data provides for quick settlement of billing disputes and access to timely, valuable customer information.**
- **Leak detection capabilities in the endpoint – enabling the City to quickly identify leaks behind the meter, reducing lost water and avoiding high bill complaints.**

Weather and traffic, continual impediments to timely meter reading and service calls with convention systems (AMR and manual), are no longer a factor with fixed network technology.

Meter data is collected for each meter in the network by an Itron 100W+ ERT and is transmitted to nearby Collectors, Repeaters or mobile readers using the unlicensed 900 MHz ISM band. The 100W+

ERT collects hourly interval data from the meter register, at the top of the hour for every ERT in the system. The 100W+ ERT bubbles-up every six minutes in Fixed Network mode and has a 20 year battery life with no battery replacement options available. The 100W+ ERT module's circuit assembly and battery pack are fully encapsulated within a specially formulated potted material that completely protects internal components from water, contaminants, corrosion, rough handling and temperature cycling.

To guard against data loss, AMI has built-in levels of redundancy throughout the system. First, the ERTs store 40 days of hourly data which can be retrieved through two-way commands. The Collectors store five days of data (for up to 100,000 ERTs each), the Network Software stores 400 days of data, and the Itron Analytics stores any amount of data specified by the City, even up to 10 years. The Collector uses Flash RAM memory with internal battery storage, and each ERT has its own battery as well. Data loss is further minimized in the event of power outages.

AMI networks offer three levels of data redundancy:

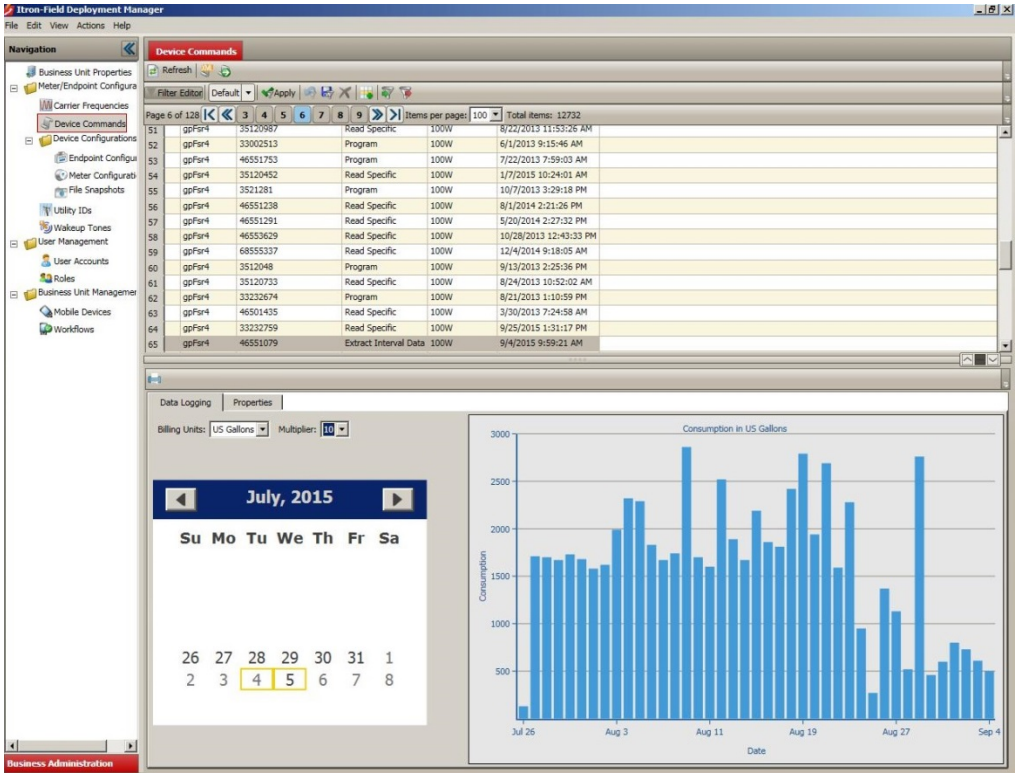
- **Temporal Redundancy – readings are sent many times during each hour.**
- **Message Redundancy – each transmission contains the current read and the last seven intervals of consumption data**
- **Spatial Redundancy – the system is designed so that each ERT is typically heard by more than one Collector.**

Handheld and drive-by AMR technology have resulted in operational savings. Yet prior to an AMI solution, the department read and billed usage on a monthly basis, a process that left significant gaps when analyzing usage data. Customer service representatives had insufficient data and information to answer customer question about when and how much water was used. Bill dispute resolutions could linger unnecessarily and often resulted in labor intensive back office procedures that negatively affected revenue and expenses along with customer dissatisfaction.

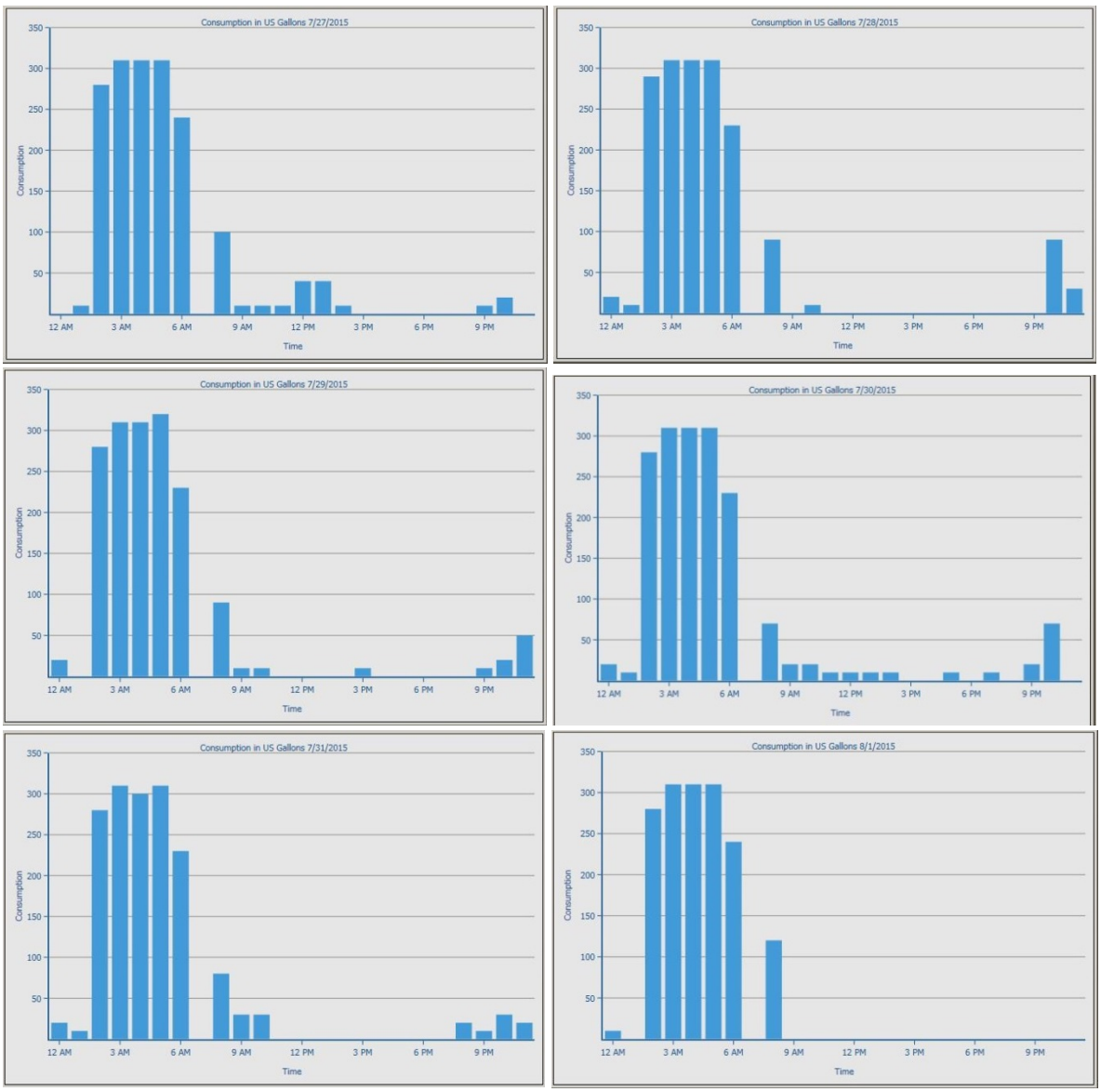
Customer service representatives will be able to share water usage with customers in greater detail – hourly, daily, weekly, monthly – in order to show trends and comparisons. Representatives will be able to more quickly and effectively resolve billing questions and concerns.

Undetected Water Usage and Leaks Create Perception of Billing Errors

Undetected water usage and undetected leaks can lead to unusually high bills and create the perception of billing errors. During IA observation it was noted a customer had called and complained about high water usage during the July and August 2015 time period and believed there to be a billing error since they were adamant there was no leak and the automatic sprinkler was set up properly. Their August bill showed usage of 58,000 gallons. The customer had a 100W ERT which had 40 days of stored usage history which the department was able to extract utilizing their FC300 handheld and Field Deployment Manager (FDM) software.



After review of the daily usage, it was noted the customer had water usage between 2am to 6am every morning.



After the customer was notified of the daily usage, there was no further follow up from the customer but monthly consumption decreased dramatically afterward. Unfortunately until AMI is installed on all customer meters, the customer service representatives will not have the hourly/daily level data in order to assist customers beyond asking the customer if they've had a leak or any unusual water use.

Customer Service Portal

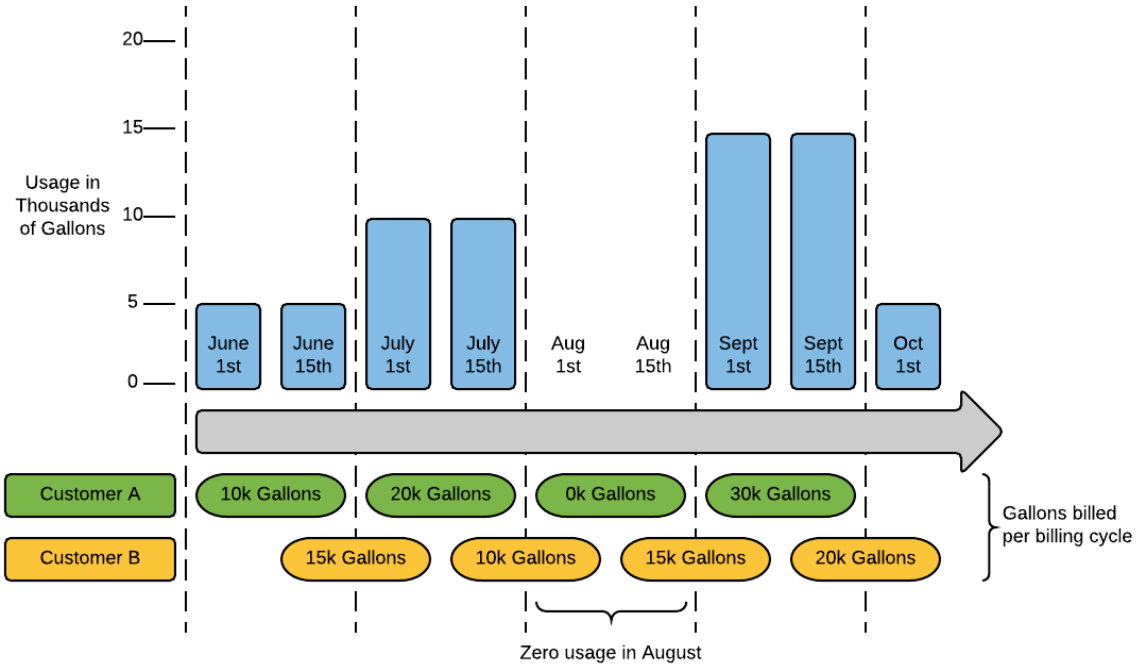
Once setup is complete, the City will offer customers access to their own consumption through a customer web portal. Customers will be able to view their own reads for the past year on a monthly basis, the last 30 days on a daily basis, and any 24 hours on an hourly basis.

Billing Cycles

Bills are issued and mailed monthly by a 3rd party vendor. There are 20 billing cycles every month which are dependent on the customer's location. Each statement typically covers 27 to 33 days. Due days vary according to the customer's billing cycle.

Customers are charged for usage during their service period. See Exhibit 3 for example customer service periods:

Exhibit 3 Meter Reading, Editing, and Billing Timeline



Both Customer A and Customer B are out of town during August and have zero usage during the month. Customer A has a 1st of the month service period whereas Customer B has a 15th of the month service period.

	Service Period	September Billing (August Usage)
Customer A	**1st - 30th**	**0k Gallons**
Customer B	**15th - 15th**	**15k Gallons**

Note: Although both customers have zero usage in August, Customer B service period only covers half of August.

Bill Editing

Billing staff reviews abnormal usage to correct errors prior to billing the customer. Accounts are automatically flagged in Naviline when meter readings show:

- **negative consumption**
- **zero consumption**
- **no meter reading**
- **duplicate reading**
- **out of range readings (see Appendix 6.12 for consumption calculation test)**
- **reading that represent billing periods of less than 20 or more than 40 days (the average billing cycle is between 29-30 days)**

Staff reviews each identified account to decide whether to:

- **Approve the read – accept as is and bill it**
- **Change or estimate read – change an existing read or if there is none, estimate the reading**
- **Issue a work order to schedule the meter to be read again**
- **Delete read – only if there is a duplicate read on the same account**

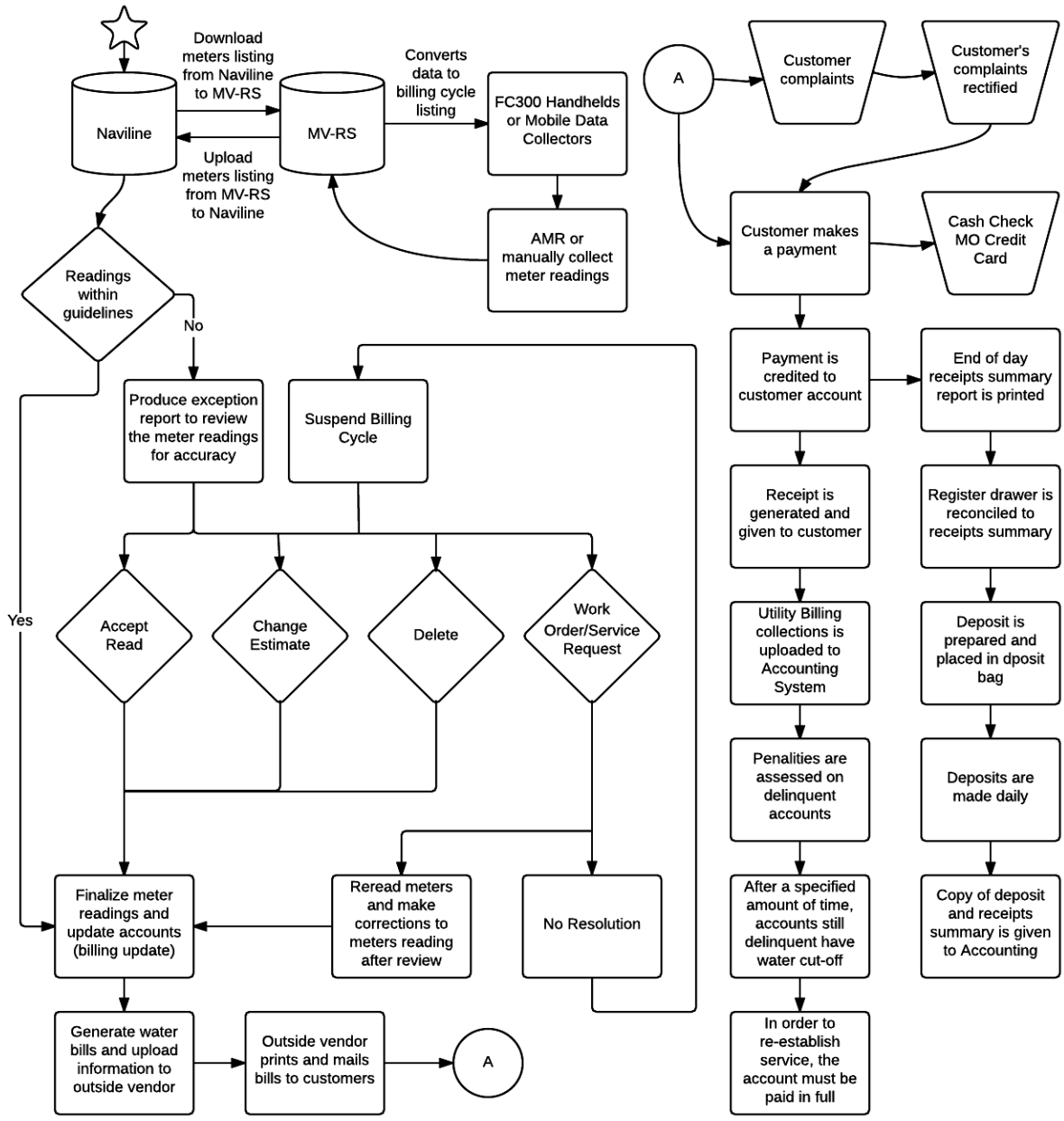
The City's policy is for bill editors to accept all high AMR readings and issue a work order for a meter inspector to re-read the meter. If the high reading is not an AMR reading and a work order is pending, bill editors estimate consumption until the inspector completes the work order and provides an actual reading. Staff generates a work order if none is pending.

Billing staff may suspend billing for an account until the issue is resolved. When an account is placed in suspense status, it is billed at a later date, separately from the ordinary bill cycle. Their goal is to resolve suspended accounts within 30 days.

Although it is very uncommon, the meter reader can incorrectly read the meter or incorrectly enter the reading into the FC300 handheld device. If the error is not flagged during the initial bill edit process as an "out of range reading" it is usually flagged as a "negative consumption" during the following billing cycle when a correct reading is entered. Tiered water and wastewater consumptions billings are adjusted for any overcharges.

Staff prepares accounts for billing after bill editing process is complete and transfers the billing files to a third party vendor for printing and mailing. Exhibit 4 shows a flow chart of the billing process.

Exhibit 4. Billing Process Flowchart



Work Order Resolution

The meter reader will re-read the meter to determine if it is consistent with the reading flagged during exception report review and logs the consumption into MV-RS. The meter reader will create work orders for Field technicians to perform routine repairs if needed, including replacing broken meter registers and wires, replacing meter lids, resyncing meters and ERT modules and any other major repairs, such as repairing meter leaks or replacing meter boxes. Meter readers record notes in the FC300 handheld device, about the meter and site and whether there are indications of a leak.

If Field Technicians are sent out to perform a work order repair, they generally identify whether the:

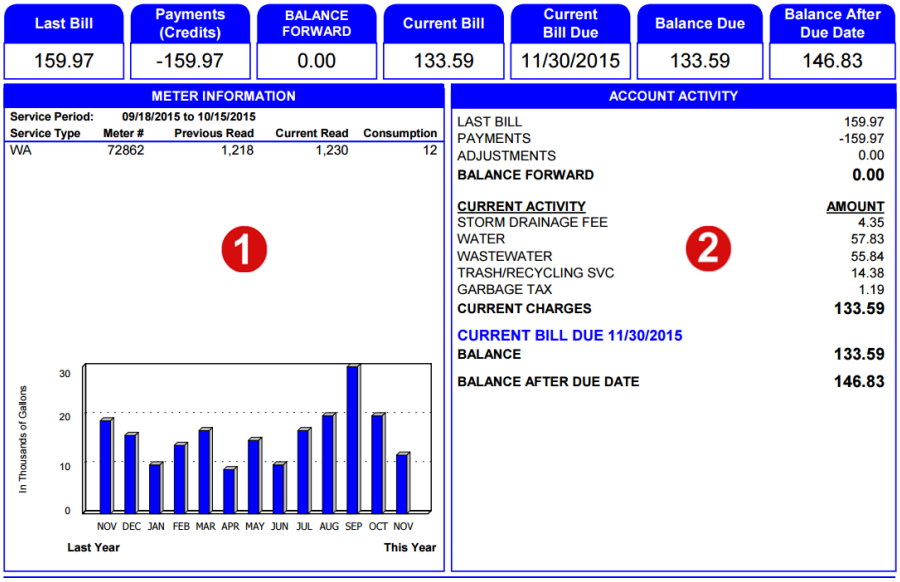
- **Meter, register or any other components are damaged**
- **Meter and register are the same size**
- **Meter and ERT are in sync**
- **Meter and ERT serial numbers match the ERT and meter numbers listed in Naviline**
- **Meter is registering water flow**
- **Meter or area around it shows any signs of a leak**

Customer Billing

The City like many other utilities uses a combination of fixed fee (base) and a variable fee (volume) for their water rate structure. Fixed charges include the price the customer pays as a base charge to help cover costs for maintaining existing infrastructure and repaying loans and bonds used to build that infrastructure. Variable charges are the price the customer pays per volume of water used, which reflects the costs of providing water, and such as costs for chemical treatment to provide safe water and energy to move and deliver water.

The City provides its customers with a breakdown of charges in the "account activity" and "meter information" section in their monthly bill. The Public Works department bills residential customers on a monthly basis.

Two examples bills are provided below:



Last Bill	Payments (Credits)	BALANCE FORWARD	Current Bill	Current Bill Due	Balance Due	Balance After Due Date
159.97	-159.97	0.00	133.59	11/30/2015	133.59	146.83

METER INFORMATION

Service Period: 09/18/2015 to 10/15/2015

Service Type	Meter #	Previous Read	Current Read	Consumption
WA	72862	1,218	1,230	12

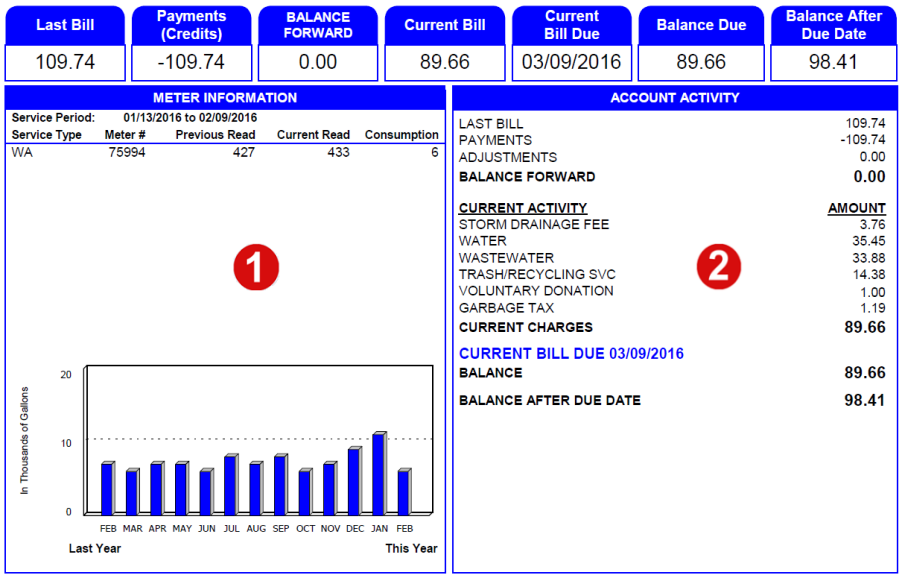
1

ACCOUNT ACTIVITY

LAST BILL	159.97
PAYMENTS	-159.97
ADJUSTMENTS	0.00
BALANCE FORWARD	**0.00**
CURRENT ACTIVITY	**AMOUNT**
STORM DRAINAGE FEE	4.35
WATER	57.83
WASTEWATER	55.84
TRASH/RECYCLING SVC	14.38
GARBAGE TAX	1.19
CURRENT CHARGES	**133.59**
CURRENT BILL DUE 11/30/2015	
BALANCE	**133.59**
BALANCE AFTER DUE DATE	**146.83**

2

Example Bill 1



Example Bill 2

Section 1. Meter Information: Graphic display of water consumption for the past year, monthly water use in thousands of gallons, the service period, meter number and meter readings.

Section 2. Account Activity: Provides a snapshot of the current bill. The account activity shows the itemized charges, total amount due, and the payment due date.

Charge Breakdown/Calculation

Storm Drainage Fee: The storm drainage fee is a sewer fee that takes into account the area on a property that is made of impermeable surface, which contributes to runoff and combined sewer overflows. For residential customers the rate is based on the total square footage of impermeable/impervious surfaces which includes: 1st floor (if two story home), garage, porch/patio, and storage building square footage.

Storm Drainage based on square footage - Residential	
Up to 1,000 sq. ft.	$1.50
1,001 sq. ft. up to 2,500 sq. ft.	$3.76
2,501 sq. ft. and up	$4.35

To calculate the impermeable surface area, the 1st floor sq. ft., garage sq. ft., porch/patio sq. ft., and storage building sq. ft. are added together in order to come up with the total sq. ft. of impermeable surface area on the property. The fee is a fixed cost and should not vary from month to month unless the domicile increases it impermeable surface area by expanding the house or the rates change. Note: Homes built prior to approximately 2006 where charged based on the total square footage of the house. Home built subsequently were assessed based on impervious square footage.

	1st Floor Sq. Ft.	Garage Sq. Ft.	Porch/Patio Sq. Ft.	Storage Sq. Ft.	Total Impervious Sq. Ft.	Monthly Fee
Calculation	A	B	C	D	E = A+B+C+D	
Example 1	2,882	454	144	0	3,480	$4.35
Example 2	1,250	411	25	0	1,686	$3.76

Trash/Recycling Service: The Trash/Recycling Service fees are collected by the Public Works department, who in turn, passes those fees on to the Environmental Services department. The rate and any subsequent rate increases are determined by the Environmental Services department.

Garbage & Recyling Service Fees	
Garbage Only	$12.38
Senior/Disabled Reduced	$13.38
Garbage & Recycling	$14.38

The fee is a fixed cost and should not vary from month to month unless the customer qualifies for a senior/disabled fee reduction. Those who qualify for a rate discount must complete an Application for Senior or Disabled Citizen Recycling Rate form. Note: Garbage Only fees only apply to those customers who opted-out of the recycling program at its inception. All new customers are required to have both Garbage and Recycling services.

	Garbage Only	Senior Reduced	Disabled Reduced	Garbage & Recycling
Fee	$12.38	$13.38	$13.38	$14.38
Example 1	No	No	No	$14.38
Example 2	No	No	No	$14.38

Voluntary Donation: Customers may opt-in to donate $1 a month to the department's Water Assistance Program. The extra money goes into a dedicated account at the City to be used exclusively to assist with water payments for qualified households once a year. Those with a delinquent water bill can apply to Grand Prairie United Charities for once a year assistance. The fund currently operates on a mere $15,000 a year in donations, which can only help about 150 families a year.

Voluntary Donation - Water Assistance Program			
	Opted-In	Amount	Total
Example 1	No	$0.00	$0.00
Example 2	Yes	$1.00	$1.00

The voluntary donation is a fixed cost and should not vary from month to month unless the customer chooses to opt-in or opt-out of the Water Assistance Program.

Garbage Tax: While many professional services are not subject to Texas sales and use tax, Texas tax code specifies that the removal of garbage, rubbish, or other solid waste is a taxable "real property service." As such, the City is required to collect and remit sales tax of 8.25% on waste hauling services. As both examples had garbage & recycling service fees of $14.38, their garbage tax value is $1.19.

Garbage & Recyling Tax			
	Taxable Amount	Tax Rate	Tax
Calculation	A	B	C = A*B
Garbage Only	$12.38	8.25%	$1.02
Senior/Disabled Reduced	$13.38	8.25%	$1.10
Garbage & Recycling	$14.38	8.25%	$1.19

Water: The water is billed volumetrically, that is, they are based on how much water a customer consumes, which is measured in 1,000 gallon increments. In addition, all customers pay a base water charge which is determined by the meter size:

- **5/8" Meter - $13.07**
- **1" Meter - $16.82**
- **1 ¼" Meter - $20.13**
- **1 ½" Meter - $21.85**
- **2" Meter - $34.57**
- **3" Meter - $107.21**
- **4" Meter - $132.92**

Of the approximately 45,500 residential meters, more than 97% or about 44,000 meters are 5/8" meters. Both of the example billings utilize 5/8" meters.

Water Minimum Base Fee			
	Meter Size	Amount	Total
Example 1	5/8"	$13.07	$13.07
Example 2	5/8"	$13.07	$13.07

The City uses a tiered rate structure (also called increasing block rate pricing) in which the rate per 1,000 gallon is higher as the usage increases. The tiered rates are follows:

- **Lifeline Tier - Total Usage 3,000 Gallons or Less (=<3k) - $0.12**
- **Tier 1 - Total Usage Over 3,000 Gallons up to 20,000 Gallons (0 to 20k) - $3.73**
- **Tier 2 - After 1st 20,000 Gallons, Each Additional 1,000 Gallons - $6.42**

In an effort to promote water conservation, tiered rates are designed to reward customers who use less water by charging the lower rates for water used in the lower tiers. The more water a customer uses, the higher the tier(s), resulting in higher charges for water use. The "Lifeline" tier was setup by the City as an exception to Tier 1 and Tier 2 pricing for those on low & fixed incomes. Usage must be 3,000 gallons or less in order to receive the Lifeline tier. See below for average costs per 1,000 gallons for the three tier rate pricing.

Lifeline Tier Up to 3,000 Gallons $0.12/1,000 Gallons	Total Usage	# gallons billed at Lifeline Tier	Total Water Cost at Lifeline Tier	Average Cost Per 1,000 Gallons
	1,000	1,000	$0.12	$0.12
	2,000	2,000	$0.24	$0.12
	3,000	3,000	$0.36	$0.12

Tier 1 Up to 20,000 Gallons $3.73/1,000 Gallons	Total Usage	# gallons billed at Tier 1	Total Water Cost at Tier 1	Average Cost Per 1,000 Gallons
	1,000	1,000	$3.73	$3.73
	2,000	2,000	$7.46	$3.73
	3,000	3,000	$11.19	$3.73
	4,000	4,000	$14.92	$3.73
	5,000	5,000	$18.65	$3.73
	6,000	6,000	$22.38	$3.73
	7,000	7,000	$26.11	$3.73
	8,000	8,000	$29.84	$3.73
	9,000	9,000	$33.57	$3.73
	10,000	10,000	$37.30	$3.73
	11,000	11,000	$41.03	$3.73
	12,000	12,000	$44.76	$3.73
	13,000	13,000	$48.49	$3.73
	14,000	14,000	$52.22	$3.73
	15,000	15,000	$55.95	$3.73
	16,000	16,000	$59.68	$3.73

	17,000	**17,000**	**$63.41**	**$3.73**
	18,000	**18,000**	**$67.14**	**$3.73**
	19,000	**19,000**	**$70.87**	**$3.73**
	20,000	**20,000**	**$74.60**	**$3.73**

	Total Usage	# gallons billed at Tier 2 - $3.73	# gallons billed at Tier 2 - $6.42	Total Water Cost at Tier 2	Average Cost Per 1,000 Gallons
Tier 2 Up to 20,000 Gallons $3.73/1,000 Gallons Each Additional 1,000 $6.42/1000 Gallons	1,000	1,000	0	$3.73	$3.73
	2,000	2,000	0	$7.46	$3.73
	3,000	3,000	0	$11.19	$3.73
	4,000	4,000	0	$14.92	$3.73
	5,000	5,000	0	$18.65	$3.73
	6,000	6,000	0	$22.38	$3.73
	7,000	7,000	0	$26.11	$3.73
	8,000	8,000	0	$29.84	$3.73
	9,000	9,000	0	$33.57	$3.73
	10,000	10,000	0	$37.30	$3.73
	11,000	11,000	0	$41.03	$3.73
	12,000	12,000	0	$44.76	$3.73
	13,000	13,000	0	$48.49	$3.73
	14,000	14,000	0	$52.22	$3.73
	15,000	15,000	0	$55.95	$3.73
	16,000	16,000	0	$59.68	$3.73
	17,000	17,000	0	$63.41	$3.73
	18,000	18,000	0	$67.14	$3.73
	19,000	19,000	0	$70.87	$3.73
	20,000	20,000	0	$74.60	$3.73
	21,000	0	1,000	$81.02	$3.86
	22,000	0	2,000	$87.44	$3.97
	23,000	0	3,000	$93.86	$4.08
	24,000	0	4,000	$100.28	$4.18
	25,000	0	5,000	$106.70	$4.27
	30,000	0	10,000	$138.80	$4.63
	35,000	0	15,000	$170.90	$4.88
	40,000	0	20,000	$203.00	$5.08

The total water charge is a combination of the monthly meter base fee (which is based on the size of the meter) and the amount of water used. See below for example water billing calculation:

	Total Usage	Usage Tier	Tier Rate per 1,000 Gallons	Water Consumed Cost at Tier 2	Water Minimum Base Fee	Total Water Bill
Calculation	A		B	C = B* (A/1000)	D	E = C + D
Example 1	12,000	Tier 1	3.73	$44.76	$13.07	$57.83
Example 2	6,000	Tier 1	3.73	$22.38	$13.07	$35.45

Wastewater: All customers pay a base wastewater charge which is determined by the meter size:

- **5/8" Meter - $11.92**
- **1" Meter - $12.91**
- **1 ¼" Meter - $15.06**
- **1 ½" Meter - $15.69**
- **2" Meter - $17.99**
- **3" Meter - $26.64**
- **4" Meter - $35.35**

Of the approximately 45,500 residential meters, more than 97% or about 44,000 meters are 5/8" meters. Both of the example billings utilize 5/8" meters.

Wastewater Minimum Base Fee			
	Meter Size	Amount	Total
Example 1	5/8"	$11.92	$11.92
Example 2	5/8"	$11.92	$11.92

Similar to water, the wastewater bill is composed of a fixed fee portion and a variable fee portion which is calculated based on how much water a customer consumes, which is measured in 1,000 gallon increments. For residential customers, wastewater is billed on the lower of either the winter monthly average (WMA) or the current month's water usage. Wastewater is billed at 80% of water used for non-residential customers and residential customers who do not have a winter month average. However, residential customers without a winter month average are not billed more than 12,000 gallons (80% of 15,000 gallons consumed) of wastewater.

Wastewater rate per 1,000 gallons

Residential wastewater billed at 80% of actual water consumption until a Winter Month's Avg. is established; 12,000 gallon maximum billed (80% of 15k gallon consumption)	**$3.66**

Each year, residential customers set the maximum amount for billing of wastewater for the next 12 months. The department takes the water usage in the months of November, December, January, and February to establish the average. The months that this usage is billed are either December-March or January-April, depending on the meter reading dates. The month with the highest consumption is dropped from the calculation. The winter months' average is based on a daily average. This daily average will then be used to determine the average used in an average month.

The winter months are when the measuring takes place because that is when the highest percentage of water used is returned to the sewer system. During the warmer summer months a large portion of water consumption is for outdoor watering which does not enter into the City's sewer system for wastewater treatment. The water that enters the storm sewers do not go to a wastewater treatment, but instead flows directly into our streams and rivers untreated.

To calculate the winter wastewater average the following information is required:

- # of days per service period for November, December, January, and February
- Water consumption per service period for November, December, January, and February

The information can be determined by utilizing the Meter Information portion (Section 1 in the example bills) of the monthly bill. Generally the month of service is allocated to the month with the most number of days in the service period.

	Service Period Start	Service Period End	# of Days Serviced	Month of Service		Consumption (thousands)
Calculation	**A**	**B**	**C = B + A**			
Example 1	11/18/2015	12/15/2015	27	December		12
Example 2	1/13/2016	2/9/2016	27	January		6

See below for example wastewater billing calculation for Example 1:

Service Period Start	Service Period End	# of Days Serviced	Month of Service		Consumption (thousands)
A	**B**	**C = B + A**			**D**
10/16/2014	11/13/2014	28	November		16
11/13/2014	12/15/2014	32	December		10
12/15/2014	1/20/2015	36	January		14
1/20/2015	2/20/2015	31	February		17*

* February has the highest consumption and is dropped from the average

Month of Service	Consumption (thousands)	# of Days Serviced
	D	C
November	16	28
December	10	32
January	14	36
Total	40	96

Total Consumption (thousands)	Total Days Serviced	Average Consumption Per Day
D	E	F = D/E
40	96	0.42

Days in a Year	Months in a Year	Average Days in a Month
G	H	J = G/H
365	12	30.42

Average Days in a Month	Average Consumption Per Day	Winter Monthly Avg. Consumption (thousands)
J	F	G = J * F
30.42	0.42	12.78

Once the WMA consumption is determined, that rate goes into effect on the next bill (generally the April bill depending on service period and billing date). So by conserving water during the winter monitoring period a consumer can lower their wastewater rate during the following year.

Utilizing the above WMA consumption amount, the wastewater fee can be calculated for several different scenarios.

Scenario	Actual Consumption (thousands)	WMA Consumption (thousands)	Wastewater rate per 1,000 gallons	Billing %	Variable Wastewater Fee

No WMA history, under 15,000 gallons consumption	**6**	**New Customer Not Available**	**$3.66**	**80%**	**$17.57**
No WMA history, over 15,000 gallons consumption	**16**	**New Customer Not Available**	**$3.66**	**80% of 15k**	**$43.92**
WMA history, actual consumption lower than WMA	**6**	**12.78**	**$3.66**	**100% of Actual**	**$21.96**
WMA history, actual consumption higher than WMA	**14**	**12.78**	**$3.66**	**WMA**	**$46.77**
Billing Example 1	**12**	**12.78**	**$3.66**	**100%**	**$43.92**

The total wastewater charge is a combination of the monthly wastewater minimum base fee (which is based on the size of the meter) and the amount of water used. See below for example water billing calculation:

Scenario	Actual Consumption (thousands)	WMA Consumption (thousands)	WW rate per 1,000 gallons	Billing %	Variable WW Fee	WW Minimum Base Fee	Total WW Fee
Billing Example 1	**12**	**12.78**	**$3.66**	**100%**	**$43.92**	**$11.92**	**$55.84**

Outdoor Water Usage – Pools & Irrigation

According to the EPA WaterSense program, on average single-family homes in this country use 30 percent of their household water outdoors; however, in many areas of the country, outdoor water use ranges from 50 to 70 percent.

Not only does outdoor water use comprise a significant portion of residential use, it stresses existing water supplies by contributing to peak demand during summer months. During these hot, dry times, utilities must increase capacity to meet residential landscape irrigation requirements, sometimes as much as three to four times the amount used during winter months. For example, rain rarely falls in Austin, Texas, during July and August; as a result, the city's overall water use increases by nearly 100 percent compared to winter use according to a study which reviewed water efficiency in Austin between 1983-2005.

The California Urban Water Conservation Council in a 1999 study concluded that for 194 homes with swimming pools, the addition of a swimming pool increased demand for water between 22 to 25 percent. The addition of an automatic sprinkler system increased demand between 54.9 to 60.6 percent. Homes with both a swimming pool and an automatic sprinkler system used the most water over 110 percent more water outdoors than homes without these amenities.

Likewise, an estimate from Arizona stated that a 3,000-square-meter turfgrass lawn in the state uses 9,000 to 15,000 gallons of water per month, whereas the same area covered with plants, shrubs, and trees uses only 800 to 1,300 gallons per month.

The average residential swimming pool in the United States contains between 18,000 and 20,000 gallons of water. All pools lose water for various reasons including natural forces or a defect in the pool construction or plumbing system.

All pools lose water naturally due to evaporation. The rate of evaporation varies according to the average relative humidity of the local climate, the daily temperature range, wind conditions, and even the amount of activity in the pool that increases splashing and other water turbulence. A residential pool without a pool cover may lose about ¼ inch of water level per day or about 2 inches a week solely due to evaporation.

Researchers at The University of Texas at El Paso conducted an in-depth statistical analysis of short-term water consumption patterns for the period from January 1994 to December 2002. The results indicated very warm temperatures quickly lead to higher water consumption. Similarly, rainfall leads to lower consumption levels within 30 days of when it occurs. The results ultimately indicated that monthly water consumption reacts fairly quickly to changes in climatic variables.

Water Leaks

The EPA Watersense program indicated household leaks account for more than 1 trillion gallons of water wasted each year in U.S. homes. Fixing household leaks can save homeowners about 10% on their water bills.

Facts about Leaks:

- **The average household's leaks can account for more than 10,000 gallons of water wasted every year, or the amount of water needed to wash 270 loads of laundry.**
- **Ten percent of homes have leaks that waste 90 gallons or more per day.**
- **A leaky faucet that drips at the rate of one drip per second can waste more than 3,000 gallons per year.**
- **A showerhead leaking at 10 drips per minute wastes more than 500 gallons per year.**

AUDIT OBJECTIVES, SCOPE, AND METHODOLOGY

OBJECTIVES

The audit was conducted to:

1) **Determine if the water meter equipment including the Automated Meter Reading (AMR) system is negatively impacting customer billing.**
2) **What is the magnitude of billing errors?**
3) **What factors could explain perceived billing errors?**

These objectives drove the scope and the methodology used for obtaining objective evidence and analysis of findings.

SCOPE AND METHODOLOGY

In order to achieve the objectives for this audit, the City's Internal Audit (IA) department implemented the following methodology:

- **Conducted initial review of the process and equipment**
- **Reviewed literature for understanding of current standards**
- **Reviewed industry literature to understand metering technology and functionality which included AMR/AMI**
- **Reviewed literature to understand AMR implementation and subsequent billing problems in other jurisdictions, and to identify the magnitude and potential causes of errors**
- **Reviewed relevant sections of the local ordinances, resolutions, and procedures**
- **Reviewed audit reports by other entities related to manual and AMR meter reading**
- **Observed staff functions, including manual and AMR meter reading, completion of work orders and customer phone calls.**
- **Examined manual and system generated meter reading and work order related data**
- **Contracted with an independent meter test facility that had no direct financial involvement along with any projects for the Public Works Department or City for the preceding five years to ensure testing would have no bias**
- **Performed validity and verification testing of a sample of the equipment to ensure conformance with the audit requirements**
- **Reviewed findings to determine which equipment could lead to non-conformance (bill error)**
- **Conducted parallel meter reading tests**
- **Completed review of customer historical billing information and performed recalculations of billings**

Once the methodology had been defined, the sample population was selected. There are approximately 45,500 residential customers serviced by the Public Works department. Traditionally in an audit, a statistically significant sample size is sufficient for a valid finding. This "stat sig" sample size can be determined in a few generally accepted ways, such as the ANSI Z method (derived from ANSI/ASQC Z1.4-2008 sampling standards) or the Sqrt(N) + 1 method. For 45,500 in the total population, ANSI (American National Standards Institute) Z would yield a sample size of 200 (0.044%

total of the population) with an Acceptance Quality Limit of 4.0% for minor defects while the Sqrt(N) + 1 method would yield a sample size of 215 (0.047% total of the population).

The Public Works Department saw a sharp increase for requests for investigations in the summer of 2015 due to high bill complaints in the south sector Peninsula area of the City. In order to determine if there was a localized issue and also wanting to report findings to customers as timely as possible, the smaller population of Peninsula residential water meters was chosen with a sample size of 50 water meters randomly selected for review and testing. The sample size covered 1.4% of approximately 3,400 residential water meters in the Peninsula area.

The following segmentation of the 50 randomly selected water meter accounts for the audit was stratified based on the City's residential 3-tiered water billing structure:

- **10 accounts/water meters from the "Lifeline" Tier (0 to 3,000 gallons consumption)**
- **20 accounts/water meters from the Tier 1 (0 to 20,000 gallons consumption)**
- **20 accounts/water meters from the Tier 2 (21,000 and over consumption)**

Generally accepted government auditing standards require that IA plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for the findings and conclusions based on the audit objectives. IA believes that the evidence obtained provided a reasonable basis for our findings and conclusions based on our audit objectives.

FINDINGS AND ANALYSIS

1.0 CITY'S RATE ORDINANCE

1.1 Water Utility Ordinance Policy

Procedure:

Determine the emphasis behind the water rate structure to the City's utility customers according to the City's Utilities and Services Ordinance.

Results:

The emphasis in the water rate structure can be found in the City's Water Rates Ordinance (Sec. 26-23). In summary, the emphasis behind the water rate structure is there should be a nominally higher water rate with higher customer consumption encouraging conservation.

1.2 Water Rate Structure

Procedure:

Determine if current utility rates comply with the City Ordinance and are readily available for customers.

Results:

Below are the current water rates for residential and nonresidential customers. Water rates show that a nominally higher water rate is applied with higher customer consumption to encourage conservation. Furthermore, the water billing rates can be found on the City's external website at:

http://www.gptx.org/city-government/city-departments/departments-g-z/public-works/water-service-water-bill/water-billing-rates

1.3 Adopting Water Rates

Procedure:

Inspect the notice of City Council meetings regarding water rate adoption and identify that the dates of notices occurred 72 hours or three days before the City Council meeting.

Results:

The City Council approved the current water rates at the City Council meeting on September 15, 2015 at 6:30 pm. The notice for the City Council meeting was published on the City's website and posted outside City Council Chambers on September 11, 2015 (three days prior).

1.4 Water Rate Set Up

Procedure:

Verify that water rates according to the approved water rates described in section 1.2 are set up within the City's utility billing system by tracing water rates to the City's utility billing setup screen.

Results:

All approved residential water rates are properly setup within the Naviline utility billing system.

2.0 RECALCULATION OF WATER BILLS

2.1 Water Charges Recalculation for Residential Customers

Procedure:

Obtain electronic copies of the Naviline utility billing register for the June 2015 to August 2015 utility billing service period. Utilizing the consumption data on the utility billing register and the residential water rates, perform the following procedures:

a. **For the 50 selected water accounts, independently recalculate each water bill portion (minimum base fee and variable tiered fee) of the utility bill using the 3-tiered formula based on the waters rates.**
b. **Compare recalculations to the City's utility billing register.**

Results:

a. **All water billing calculations were based on the City's rate and fee ordinance. The water bill portion of the utility bills was recalculated using the 3-tiered formula based on residential rates. See Appendix 6.1 for recalculations.**
b. **There were no resulting discrepancies or differences to the Naviline utility billing register to the recalculations.**

2.2 Wastewater Charges Bill Recalculation for Residential Customers

Procedure:

Obtain electronic copies of the Naviline utility billing register for the June 2015 to August 2015 utility billing service period. Utilizing the consumption data on the utility billing register and the residential wastewater rates, perform the following procedures:

a. **For the 50 selected water accounts, independently recalculate each wastewater bill portion (minimum base fee and variable fee) of the utility bill using the Winter's Month Average (WMA) consumption formula.**
b. **For residential wastewater accounts without WMA established, verify wastewater is billed at 80% of actual water consumption until a Winter Month's Avg. is established.**
c. **For residential wastewater accounts without WMA established and have exceed the 12,000 gallon billing cap, verify account did not bill over the cap.**
d. **Compare recalculations to the City's utility billing register.**

Results:

a. **All wastewater calculations were based on the City's rate and fee ordinance. The wastewater bill portion of the utility bills was recalculated using the Winter's Month Average (WMA) consumption formula. See Appendix 6.2 for recalculations.**
b. **One account did not have the established WMA history and verified wastewater was billed at 80% of actual water consumption.**
c. **Two accounts did not have the established WMA history and exceeded 12,000 in water consumption. Verified wastewater was billed at the 12,000 gallon cap.**
d. **There were no resulting discrepancies or differences to what was on the Naviline utility billing register to the recalculations.**

2.3 Garbage/Recycling & Garbage Taxes Recalculation

Procedure:

Obtain electronic copies of the Naviline utility billing register for the June 2015 to August 2015 utility billing service period. Utilizing the consumption data on the utility billing register and the residential garbage/recycling and garbage tax rates, perform the following procedures:

a. **For the 50 selected water accounts, independently recalculate each garbage/recycling and garbage taxes bill portion of the utility bill.**

b. Compare recalculations to the City's utility billing register.

Results:

a. The garbage/recycling and garbage tax bill portion of the utility bills was recalculated based on residential rates. See Appendix 6.3 for recalculations.
b. There were no resulting discrepancies or differences to what was on the Naviline utility billing register to the recalculations. This portion of the utility bill stayed the same for June 2015 through August 2015 water billing cycles for each account selected.

2.4 Storm Drainage Fee Recalculation

Procedure:

Obtain electronic copies of the Naviline utility billing register for the June 2015 to August 2015 utility billing service period. Utilizing the consumption data on the utility billing register and the storm drainage fee rates, perform the following procedures:

c. For the 50 selected water accounts, independently recalculate storm drainage fee bill portion of the utility bill.
d. Compare recalculations to the City's utility billing register.

Results:

c. The storm drainage bill portion of the utility bills was recalculated based on residential rates. See Appendix 6.4 for recalculations.
d. There was one resulting discrepancies or differences to what was on the Naviline utility billing register to the recalculations. IA obtained the Impact and Tap Fees form from which the square footage is obtained and noted the wrong storm drainage code was entered resulting in a monthly $0.59 under billing for the customer. The house was built in 2003 and the total loss in storm drainage fees to the City was approximately $84.96. The error has been corrected moving forward.

3.0 WATER BILLING PROCESS

3.1 Document Water Billing Procedures

Procedures:

a. Document the City's utility billing procedures based on interviews of personnel detailing the water billing mail outs, handling of payments for utility, and depositing of utility payments.
b. Determine if there are any control deficiencies based on the procedures documented
c. Determine if there are any instances where controls were not being followed.

Results:

a. See Exhibit 4 for a flowchart of the City's utility billing process.

b. No observations of any instances of where controls described presented control deficiencies.
c. No observations of any instances where controls were not being followed or were being circumvented.

3.2 Third-party Billing Statements Review

Procedures:

Obtain copies of the customer water bill statements sent by the 3rd party vendor for the June 2015 to August 2015 utility billing service period. Utilizing the consumption data on the water billing register, perform the following procedures:

a. For the 50 selected water accounts, verify the entire customer water bill statement including the water, wastewater, and fee (garbage/recycling, storm drainage, etc.) portion of the utility bill agreed with the water billing register for the selected time period.

Results:

There were no resulting discrepancies or differences to what was on the Naviline utility billing register to the 3rd party vendor customer water bill for the review period. See Appendix 6.11 for results.

4.0 METER ACCURACY

4.1 Meter Read Observations

Procedures:

a. For the 50 selected customer accounts physically observe the meter readings (manual reads).
b. For the 50 selected customer accounts obtain the Encoder/Receiver/Transmitter (ERT) module readings via the meter reading system handheld device, FC300.
c. Trace and compare the physically observed readings (manual) to the ERT reading.

Results:

a. All 50 meters were physically read.
b. ERT readings were obtained from 48 of 50 meters. Two meters did not send any signals indicating possible failed battery/electronics. When an automated meter read transmission attempt fails, the Public Works department policy is to submit a work order for re-read. IA reviewed MV-RS meter reading system and noted work orders for re-reads had been submitted and completed for the two inoperable ERTs. Both ERTS were the older style 50W ERTs with manufacture dates of June 2006 and September 2007.
c. All billing rates are based on increments of 1,000 gallons consumed. The resolution for the Badger Model 25 registers is single digits (utilizing the sweeping arm). The resolution for the Itron FC300 transmission reads is the tens digits. Values in the single digits are

truncated. Both the MV-RS meter reading software and the Naviline billing software truncates all meter readings to the thousands digits.

Resolutions for various devices/systems and what readings would be shown:

millions	hundred thousands	ten thousands	thousands	hundreds	tens	singles

- **Register – Singles**

0	0	0	9	8	7	6

- **ERT/FC300/Mobile Data Collector - Tens**

0	0	0	9	8	7	

- **MV-RS Meter Reading System - Thousands**

0	0	0	9			

- **Naviline Billing System – Thousands**

0	0	0	9			

- **3rd Party Mailed Customer Billing Statements – Thousands**

0	0	0	9			

Of the remaining 48 available customer accounts with transmitted ERT data, it was noted 22 (46% of sampled population) had variances to what was shown on the manual register with ranges from -10 to 70 gallons. Approximately 91% of ERTs with variances were under reading actual amounts. See Appendix 6.5 for results.

As these were all AMR enabled registers, this variance would not typically be known by the department until either there was an issue with the ERT (malfunction/battery failure), register (leak), or a customer initiated/system generated re-read.

While not typical or common, for AMR registers with ERT variances the department procedure is as follows:

- **If this is the first time there is a deviation between the ERT and the manual reading, the ERT is reprogrammed and resynced to the manual reading.**
- **During a subsequent follow-up if it is noted there is another variance, the ERT is exchanged and replaced with a new ERT and the defective ERT is returned to the manufacturer for warranty.**

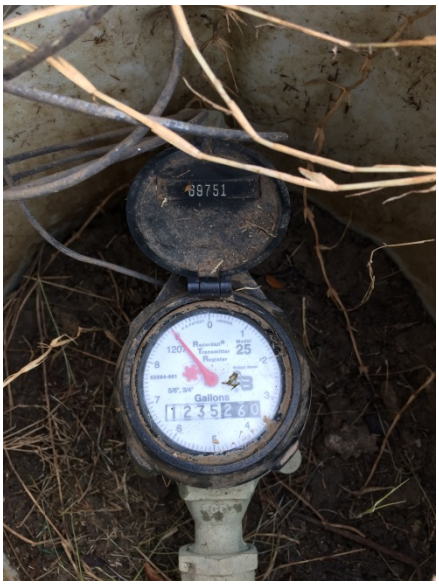
As the readings are truncated to the thousands of gallons and these deviations are not cumulative (a -10 gallon variance one month carries over to the next month), the impact of this resolution drift is minimal/immaterial. See below for non-cumulative billing statement impact for highest and lowest variances from population.

	Variance Impact on Billing	
Billing Tier Charges	**-10 gallons**	**70 gallons**
Lifeline Tier $0.12/1,000 Gallons	-$0.001	$0.008
Tier 1 $3.73/1,000 Gallons	-$0.037	$0.26
Tier 2 $6.42/1000 Gallons	-$0.064	$0.45

General Observation:

a. **As all meters were AMR equipped meters, readings are completed via wireless readings by FC300 handheld devices or mobile data collectors without necessitating the need to open the register cover and manually observing the meter readings.**

For the two ERTs which were no longer sending signals, IA noted the register covers were open and the register dials had been cleaned to allow manual observations of the register dials. Whereas the remainder of the registers had either their covers closed and/or the dial registers were obscured by mud/dirt/debris.



Left is a picture of general condition of AMR enabled register which is wirelessly read and on the Right is the condition of the register with the inoperable ERT showing the visible dial registers indicating manual re-read was performed.

4.2 ERT Read Observations

Procedures:

a. Trace ERT readings from the meter reading system handheld device, FC300 to what is recorded in the City's utility meter reading system, MV-RS.

Results:

a. ERT readings were obtained from 48 of 50 meters with functioning ERTs. See Appendix 6.6 for results.

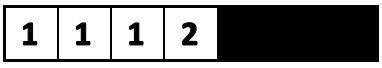
47 of out the 48 FC300 readings agreed to MV-RS meter reading system.

Location ID	FC300 Read (tens)	FC300 Read Trunc (thousands)	MV-RS (thousands)	Difference
107615	111,298	1,112	1,113	-1

Although FC300 readings were obtained by IA on the same day as the AMR mobile data collectors collected the MV-RS readings, readings were not taken at the exact same time. As such, there would have been a timing difference between collections where a customer could have had some water usage. The difference between readings was actually only 20 gallons but due to truncating the difference between the FC300 and MV-RS reading would show a difference of 1,000 gallons.

- **IA FC300 reading**

- **FC300 - Truncating**



- **Customer Usage of 20 gallons after IA reading**

- **Mobile Data Collector/MV-RS reading**

Therefore, there was no identified billing impact observed during review of ERT to MV-RS download.

4.3 Review of Third-Party Testing of Meter Accuracy

Accuracy denotes the comparison between the indicated values of water delivered of the meter being tested as compared to the true value determined by the test system. In the water industry, the meter's accuracy is most commonly called the percent registration (% registration). A water meter that has 101% accuracy at a given flow rate indicates that 1% more water has been delivered to the proving system than the testing system indicates (this error is called 1% fast). Conversely, a meter that has a 99% registration indicates 1% less water than that delivered to the prover (i.e., 1% slow).

In general, the larger the meter, the less sensitive the meter is to small volumes of water passing through the mechanism. A typical residential meter (5/8" or 3/4") will only record usage when the flow rate is greater than one pint of water per minute. Also, meter sensitivity decreases with age. A 10 year old 5/8" meter usually only records flows greater than 2 pints per minute (.95 LPM), depending on usages and water quality.

The water meter review and testing was designed to locate inconsistencies in the metering of water and to identify meter accuracy problems resulting in any negative results impacting customer billing. The evaluation was conducted by an independent vendor following American Water Works Association (AWWA) standard specifications. The flow rates used are the AWWA recommended flow rates summarized in "Water Meters – Selection, Installation, Testing and Maintenance" (AWWA M-6).

Standards for the construction, accuracy and servicing of cold water meters have been developed and published by the AWWA for over 20+ years. Although compliance with the provisions of these guidelines is not mandatory, manufacturers comply with them as a standard practice since most municipalities will only purchase AWWA-compliant meters. The City of Grand Prairie requires AWWA compliant residential meters. The AWWA Standard C700 is currently the in-force standard for positive displacement meters.

Standard C700 establishes performance minimums for new, rebuilt, and repaired meters under two different flow conditions along with a changeover flow condition for residential-size meters, as shown in the following table.

Table 5-3 Test requirements for new, rebuilt, and repaired cold-water meters*

Size in.	Maximum Rate (All Meters) Flow† Rate gpm	Test Quantity†† gal	Test Quantity†† ft³	Accuracy Limits percent	Change Over Point (All Meters) Flow** Rate gpm	Test Quantity†† gal	Test Quantity†† ft³	Accuracy Limits percent	Minimum Rate (New and Rebuilt) Flow Rate gpm	Test Quantity†† gal	Test Quantity†† ft³	Accuracy Limits percent	Minimum (Repaired) Accuracy Limits percent (min.)
Displacement Meters (AWWA C700 and C710)													
5/8	15	100	10	98.5–101.5	2	10	1	98.5–101.5	1/4	10	1	95–101	90
5/8 × 3/4	15	100	10	98.5–101.5	2	10	1	98.5–101.5	1/4	10	1	95–101	90
3/4	25	100	10	98.5–101.5	3	10	1	98.5–101.5	1/2	10	1	95–101	90
1	40	100	10	98.5–101.5	4	10	1	98.5–101.5	3/4	10	1	95–101	90
1 1/2	50	100	10	98.5–101.5	8	100	10	98.5–101.5	1 1/2	100	10	95–101	90
2	100	100	10	98.5–101.5	15	100	10	98.5–101.5	2	100	10	95–101	90
3	150	500	50	98.5–101.5	20	100	10	98.5–101.5	4	100	10	95–101	90
4	200	500	50	98.5–101.5	40	100	10	98.5–101.5	7	100	10	95–101	90
6	500	1,000	100	98.5–101.5	60	100	10	98.5–101.5	12	100	10	95–101	90

The table below shows the selected AWWA testing methodology performed by the outside meter testing vendor.

5/8" x 3/4" Residential Meters New, Rebuilt, and Repaired Standard			
Flow Rate	**Flow (gallons per minute)**	**Upper (%)**	**Lower (%)**
High Flow Rate	**15**	**101.5**	**98.5**
Intermediate Flow Rate	**2**	**101.5**	**98.5**
Low Flow Rate	**0.25**	**101**	**95**

The test results were subjected to weighted averages (WA) of 15%-70%-15% as set by the AWWA. The percentages refer to the weighting given to the test results at low flow, intermediate flow and high flows. The highest weighting is given to intermediate flows since small meters usually do not operate at low or high flows for extended lengths of time under normal usage.

Determining Accuracy Limits for Meter Types

For displacement, multi-jet, propeller, and turbine meters, a typical method of establishing test-flow-percent accuracy is the algebraic sum of 15% of the low flow results, 70% of the intermediate flow results, and 15% of the maximum flow results. For compound and fire-service meters, the normal test-flow-percent accuracy should be one third of the algebraic sum of the accuracy results at the maximum test-flow rate of the main line meter and the maximum and intermediate test-flow rates of the bypass meter.

Although the testing criteria by the independent tester followed C700 guidelines and accuracy limits, IA evaluated the meters according the AWWA's "required accuracy limits for compliance with guidelines" threshold since the tested residential meters were not new nor have they been rebuilt or repaired.

Accuracy Limits for Removal From Service

Meters with determined accuracy limits beyond those shown in Table 5-1 should not remain in service unless repaired. Determining the optimum number of years a meter should remain in service between tests is achieved by testing 5 percent of those meters

Table 5-1 Required accuracy limits for compliance with guidelines

Meter Type (all sizes)	Accuracy Limits as Found by Testing *percent*	
	Normal Test Flow Rates	Minimum Test Flow Rates
Displacement	96–102	80–102
Multi-jet	96–102	80–104
Propeller and turbine	96–103	Not applicable
Compound and fire service	95–104	Not applicable

The table below shows the selected AWWA accuracy limits the used meters were tested within.

Displacement Accuracy Limits (All Sizes)	
Normal Test Flows Rates (High, Intermediate)	**Minimum Test Flow Rates (Low)**
96-102%	**80-102%**

Furthermore, the meter reading evaluation methodology followed the audit steps AWWA recommended in "Water Audits and Loss Control Programs" (AWWA M-36).

Step 7-1B. Test residential meters. A random sample of residential meters should be tested; 50 to 100 is a sufficient number, but the optimal number to be tested depends on the size of the customer meter population, the degree of confidence required in the test results, and the variance in the actual test results observed. Residential meters may be tested on a test bench or sent to the factory or a consultant for testing. (For more information see AWWA Manual M6, *Water Meters—Selection, Installation, Testing, and Maintenance.*)

As noted above, 50 to 100 random samples was a sufficient number and residential meters may be sent to a consultant for testing.

Table 2-11 Weighting factors for flow rates related to volume percentages for ⅝-in. and ¾-in. water meters*

Percent of Time	Range, gpm	Average, gpm	% Volume†
15	Low 0.50–1.0	0.75	2.0
70	Medium 1–10	5.00	63.8
15	High 10–15	12.50	34.2

Table 2-12 Meter testing data from a random sample of 50 meters for County Water Company

Test Flow Rates, gpm	Mean Registration, %
Low (0.25)	88.8
Medium (2.0)	95.0
High (15.0)	94.0

Table 2-13 Calculation of residential water meter error

Percent Volume* (%V)	Total Sales Volume† (Vt), mil gal	Volume at Flow Rate (Vf) (%V × Vt), mil gal	Meter Registration (R)‡, %	Meter Error (ME) ME = Vf/(0.01R) – Vf, mil gal	Meter Error (ME), mil gal
2.0	2,318..8	46.38	88.8	[(46.38/0.888) – 46.38]	5.85
63.8	2,318.8	1,479.39	95.0	[(1,479.39/0.95) – 1,479.39]	77.86
34.2	2,318.8	793.03	94.0	[(793.03/0.94) – 793.03]	50.62
			Total residential meter error (Line 18 of Figure 2-4)		134.33

* Data from Table 2-11.
† Based on residential water sales data in Table 2-8.
‡ Data from Table 2-12.

Utilizing the mean registration % from the test results of the 50 selected meters, IA recalculated the residential water meter error in accordance with "Water Audits and Loss Control Programs" (AWWA M-36) as per the above M-36 calculation tables (2-11, 2-12, & 2-13).

Procedures:

a. **Remove and replace 50 selected meters by non-City staff.**
b. **Send off the selected meters to 3rd party independent meter tester who has not had business dealings with the City for at least 5 years and has no ongoing affiliations that may present conflicts of interest.**
c. **Review flow rate results against AWWA C700 New, Rebuilt, or Repaired Water Meter Standards**
d. **Review flow rate results against AWWA Accuracy Compliance Guideline for All Meters**
e. **Calculate the residential water meter error and the impact against billing and revenue in accordance with AWWA Water Audits and Loss Control Program M-36 tables.**

Results:

a. **IA had a local vendor remove and replace the 50 selected residential meters.**
b. **See results from 3rd party independent meter tester in Appendix 6.7.**
c. **Of the 50 meters tested, 7 meters were outside the specifications under AWWA C700 standards. *Note AWWA C700 standards are for new, rebuilt, or repaired meters and results are shown for illustrative purposes only since tested meters were not new, rebuilt, or repaired meters.**

AWWA C700 for New, Rebuilt, and Repaired Residential Meters

Flow Rate	Over Limit	Under Limit	Highest Reading Over	Lowest Reading Under	% Out of Spec. - High	% Out of Spec. - Low
High Flow	0	4	n/a	93.87%	n/a	4.63%
Intermediate Flow	0	1	n/a	98%	n/a	0.50%
Low Flow	2	1	102%	92%	0.50%	3%

See below for billing statement impact per 1,000 gallons for the highest and lowest % out of specification from population.

% Out of Spec. - Impact on Billing

	4.63% -	0.50% +
Billing Tier Charges	Under bill per 1,000 gallons	Over bill per 1,000 gallons
Lifeline Tier $0.12/1,000 Gallons	($0.0056)	$0.0006
Tier 1 $3.73/1,000 Gallons	($0.17)	$0.02
Tier 2 $6.42/1000 Gallons	($0.28)	$0.03

d. Of the 50 meters tested, 1 meter was outside the specifications under the AWWA Accuracy Compliance Guideline for All Meters standard.

AWWA Accuracy Compliance Guideline for All Meters

Flow Rate	Over Limit	Under Limit	Highest Reading Over	Lowest Reading Under	% Out of Spec. - High	% Out of Spec. - Low
High Flow	0	1	n/a	93.87%	n/a	4.63%
Intermediate Flow	0	0	n/a	n/a	n/a	n/a
Low Flow	0	0	n/a	n/a	n/a	n/a

See below for billing statement impact per 1,000 gallons for the low % out of specification from the population.

% Out of Spec. - Impact on Billing

	4.63% -
Billing Tier Charges	Underbill per 1,000 gallons
Lifeline Tier	($0.0056)

$0.12/1,000 Gallons	
Tier 1 $3.73/1,000 Gallons	**($0.17)**
Tier 2 $6.42/1000 Gallons	**($0.28)**

e. **The projected total meter error for 2015 residential volumes was an under billing of approximately 3.4 million gallons out of a total of 4.88 billion residential volume sold. The loss in revenue based on 2014/2015 budget year weighted average of residential customers in each tier was approximately $15,134.81 out of total residential water billing of $26,760,579.**

AWWA Table 2-11 Weighting factors for flow rates related to volume percentages for 5/8-in. and 3/4-in. water meters

Percentage of Time	Range, gpm	Average, gpm	Weighted Avg (WA) of GPM	% Volume
15	Low 0.50-1.0	0.75	0.1125	2%
70	Medium 1-10	5	3.5	64%
15	High 10-15	12.5	1.875	34%
		Total WA	5.4875	

AWWA Table 2-12 Meter testing data from a random sample of 50 meters for City of Grand Prairie

Test Flow Rates, gpm	Mean Registration %
Low (0.25)	99.40%
Medium (2.0)	100.10%
High (15.0)	99.60%

AWWA Table 2-13 Calculation of residential water meter error

% Volume	2015 Total Residential Usage Volume (Thousands)	Volume at Flow Rate (Thousands)	Meter Registration %	Meter Error (Thousands)
2%	3,940,682	80,788	99.40%	488
64%	3,940,682	2,513,419	100.10%	-2,511
34%	3,940,682	1,346,474	99.60%	5,408
			Total Meter Error	3,384

Calculation of estimated total loss revenue due to residential meter error

Tier	Rate	Weight Average of Residential Customers in Each Tier	Total Meter Error (Thousands)	Weight Average Lossed Revenue Due to Meter Error
Life Line Tier	$0.12	6%	3,384	$25.22
Tier 1 (0 to 20k)	$3.73	58%	3,384	$7,302.79
Tier 2 (21k and up)	$6.42	36%	3,384	$7,806.80
	Projected 2015 Total Lossed Revenue Due to Meter Error			$15,134.81

5.0 ANALYTICAL DATA

Analytical data was prepared to present the reasons for high water consumption and high water billings during June 2015 through September 2015. Analytical data was also reviewed to show correlations between the costs to the City, water pumped, and rainfall amounts.

5.1 Weather and Water Consumption Data (Trend Expectation)

Procedures:

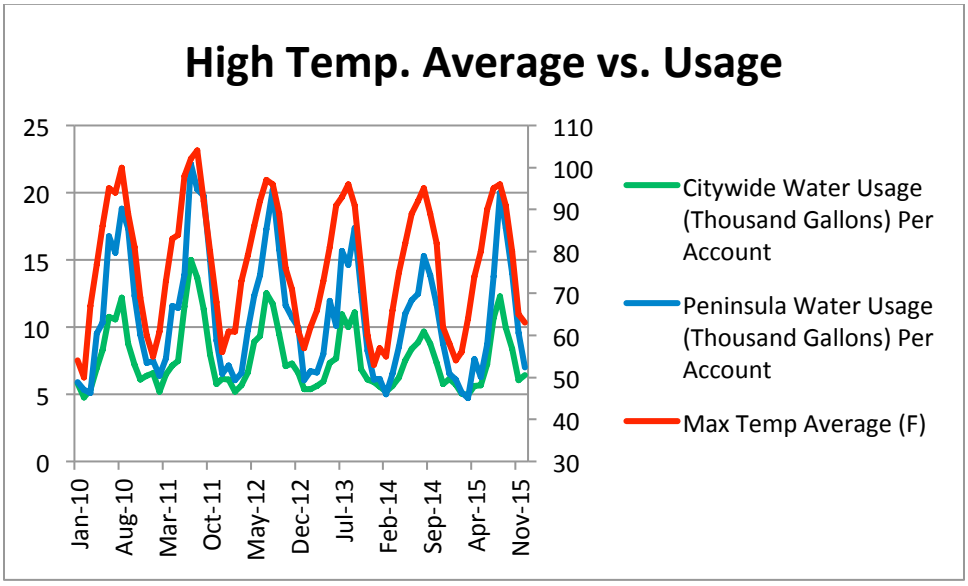
a. **Review data indicating consistencies with the water consumption fluctuation to temperature and precipitation totals.**
b. **Trace analytical data to the City's detail records and weather center information.**

Results:

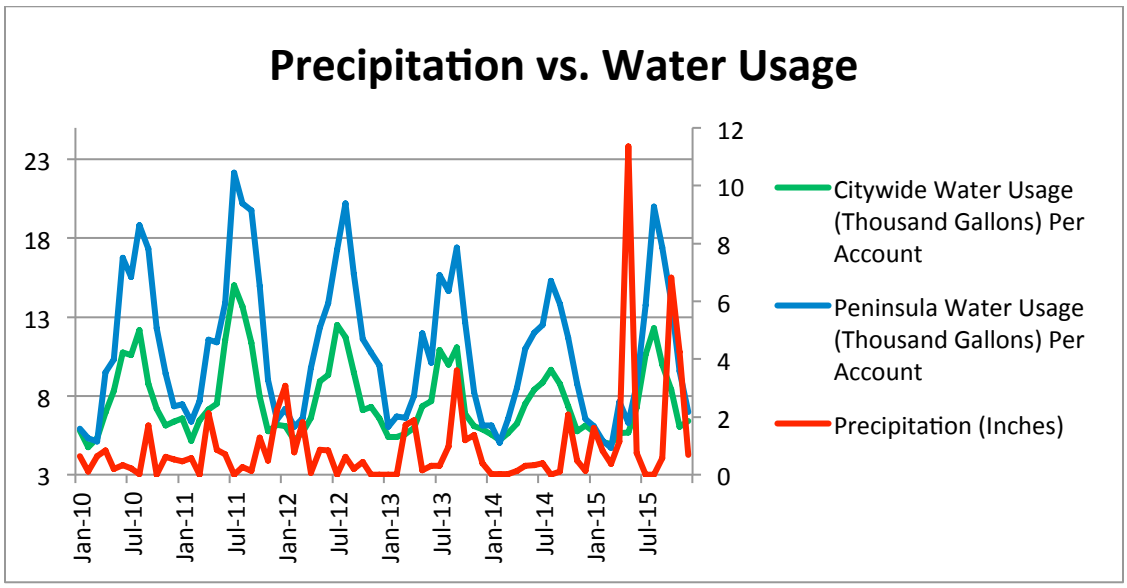
a. **See Appendix 6.8 for analytical data on water consumption and temperature and precipitation totals.**
b. **All analytical data was traced to detail documentation from the City's utility billing software and weather center information on www.wunderground.com for Grand Prairie municipal airport.**

General Observation:

The analytical data suggests that water consumption is higher when the temperature is higher. As noted before, studies show very warm temperatures quickly lead to higher water consumption.



2015 had record breaking rains in May (11.36 inches) followed by 70 days of zero precipitation (July 1st through September 8th) during the hottest part of the year.



The analytical data suggest that water consumption is higher when it is drier.

Monthly Average High Temperature for the City of Grand Prairie – 2010-2015

	2010	2011	2012	2013	2014	2015
January	54	55	61	57	57	54
February	50	61	61	62	55	56
March	67	73	73	66	66	64
April	77	83	79	73	75	74
May	86	84	86	81	82	80
June	95	98	92	91	89	90
July	94	102	97	93	92	95
August	100	104	96	96	95	96
September	89	92	89	91	89	91
October	81	80	76	76	82	80
November	69	68	71	60	62	65
December	60	56	61	53	58	63
Average	77	80	79	75	75	76

5.2 Water Usage Peninsula vs. Citywide

Procedures:

a. **Review data from the City's utility billing software for monthly Citywide and Peninsula water usage.**
b. **Trace analytical data to the City's detail records.**

Results:

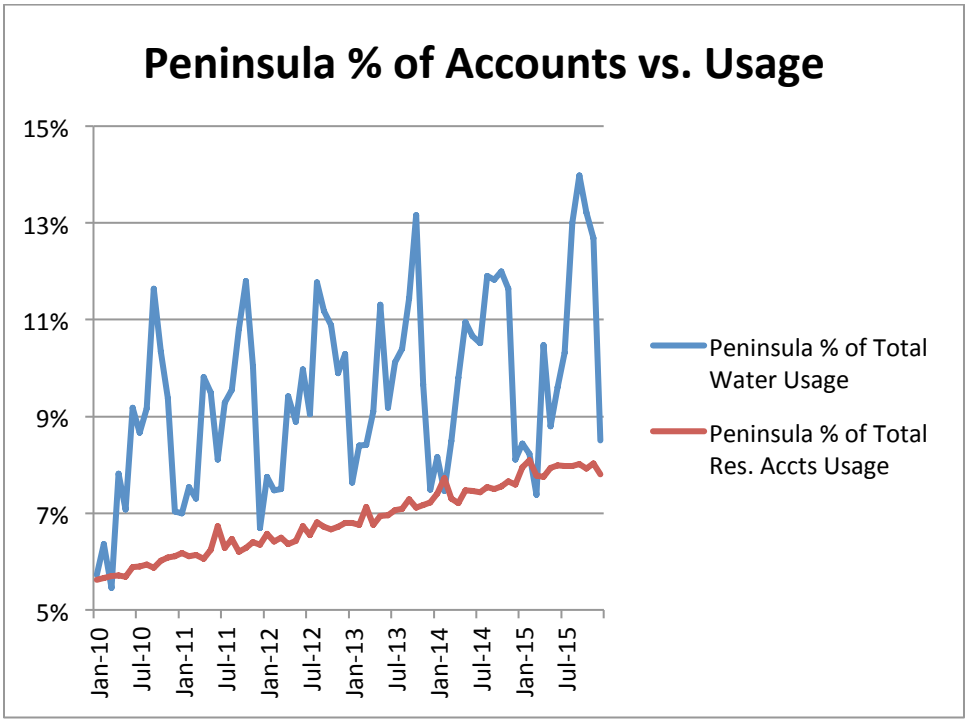
a. See Appendix 6.8 for analytical data on water usage totals and usage by account.
b. All analytical data was traced to detail documentation from the City's utility billing software.

General Observations:

From 2010 through the 2015 review period, the Peninsula area of the City has steadily grown from approximately 6% to almost 8% of total residential water accounts Citywide, and has used a greater percent of Citywide water consumption (from 8.5% to currently 10.9%).

Year	2010	2011	2012	2013	2014	2015
Peninsula % of Citywide Res. Water Accounts	5.8%	6.3%	6.6%	7.0%	7.5%	7.9%
Peninsula % of Citywide Water Usage	8.5%	9.1%	9.7%	9.9%	10.4%	10.9%

During the summer periods, the Peninsula area percentage of overall Citywide water consumption increases greatly compared to the rest of the City hitting a high of 13.98% total citywide consumption in September of 2015.



From the graph above, it is noted that the Peninsula area uses a disproportionate total % of water increasing during the warmer months and decreasing in the cooler months.

Peninsula % of Total Residential Water Usage

	2010	2011	2012	2013	2014	2015
Jan	6%	7%	8%	8%	8%	8%
Feb	6%	8%	7%	8%	7%	8%
Mar	5%	7%	7%	8%	8%	7%
Apr	8%	10%	9%	9%	10%	10%
May	7%	10%	9%	11%	11%	9%
Jun.	9%	8%	10%	9%	11%	10%
Jul	9%	9%	9%	10%	11%	10%
Aug	9%	10%	12%	10%	12%	13%
Sept	12%	11%	11%	11%	12%	14%
Oct	10%	12%	11%	13%	12%	13%
Nov	9%	10%	10%	10%	12%	13%
Dec	7%	7%	10%	7%	8%	9%

Peninsula % of Total Residential Accounts

	2010	2011	2012	2013	2014	2015
Jan	6%	6%	7%	7%	7%	8%
Feb	6%	6%	6%	7%	8%	8%
Mar	6%	6%	6%	7%	7%	8%
Apr	6%	6%	6%	7%	7%	8%
May	6%	6%	6%	7%	7%	8%
Jun.	6%	7%	7%	7%	7%	8%
Jul	6%	6%	7%	7%	7%	8%
Aug	6%	6%	7%	7%	8%	8%
Sept	6%	6%	7%	7%	7%	8%
Oct	6%	6%	7%	7%	8%	8%
Nov	6%	6%	7%	7%	8%	8%
Dec	6%	6%	7%	7%	8%	8%

Peninsula Water Usage (Thousand Gallons) Per Account

	2010	2011	2012	2013	2014	2015
Jan	6	7	7	6	6	6
Feb	5	6	6	7	5	5
Mar	5	8	7	7	7	5
Apr	10	12	10	8	9	8
May	10	11	12	12	11	6
Jun.	17	14	14	10	12	9
Jul	16	22	17	16	12	14
Aug	19	20	20	15	15	20
Sept	17	20	16	17	14	17
Oct	12	15	12	13	12	14
Nov	9	9	11	8	9	10
Dec	7	7	10	6	7	7
Ave.	11	13	12	10	10	10

Citywide Water Usage (Thousand Gallons) Per Account

	2010	2011	2012	2013	2014	2015
Jan	6	7	6	5	6	6
Feb	5	5	5	5	5	5
Mar	5	6	6	6	6	5
Apr	7	7	7	6	6	6
May	8	7	9	7	8	6
Jun.	11	12	9	8	8	7
Jul	11	15	13	11	9	11
Aug	12	14	12	10	10	12
Sept	9	11	9	11	9	10
Oct	7	8	7	7	7	8
Nov	6	6	7	6	6	6
Dec	6	6	7	6	6	6
Ave.	8	9	8	7	7	7

The joint study released in 2010 by the Lone Star Chapter of the Sierra Club and the National Wildlife Federation (McCormick and Walker 2010) found summer monthly municipal water consumption in Texas increased by 58 percent when compared to winter monthly municipal consumption. Winter consumption was considered a proxy for indoor consumption, and summer use in excess of winter use was assumed to be for outdoor purposes.

5.3 Pool Permits – Peninsula vs. Citywide

Procedures:

a. **Review data from the City's utility billing software for Pool Permit records for the City and Peninsula area.**
b. **Trace analytical data to the City's detail records.**

Results:

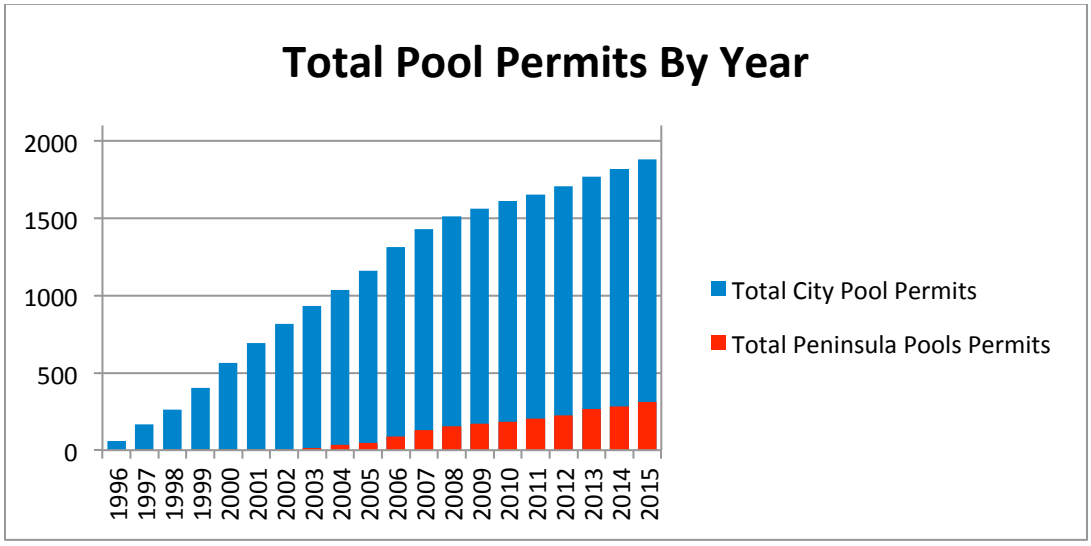
a. **See Appendix 6.9 for analytical data on Peninsula pool permits as a percentage of citywide pool permits.**
b. **All analytical data was traced to detail documentation from the City's utility billing software.**

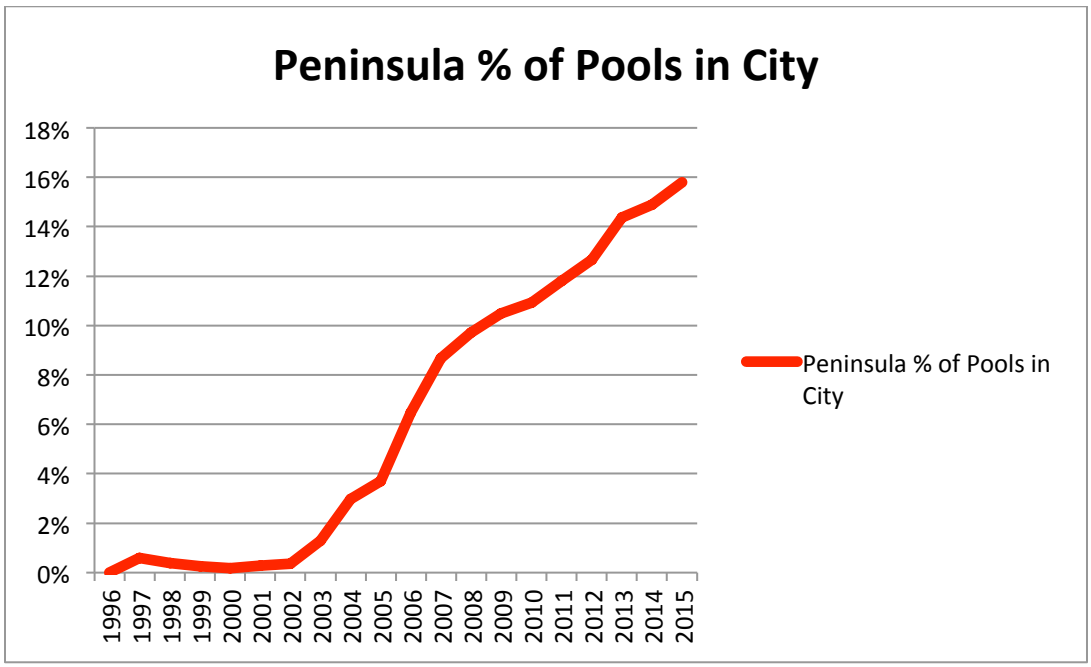
General Observations:

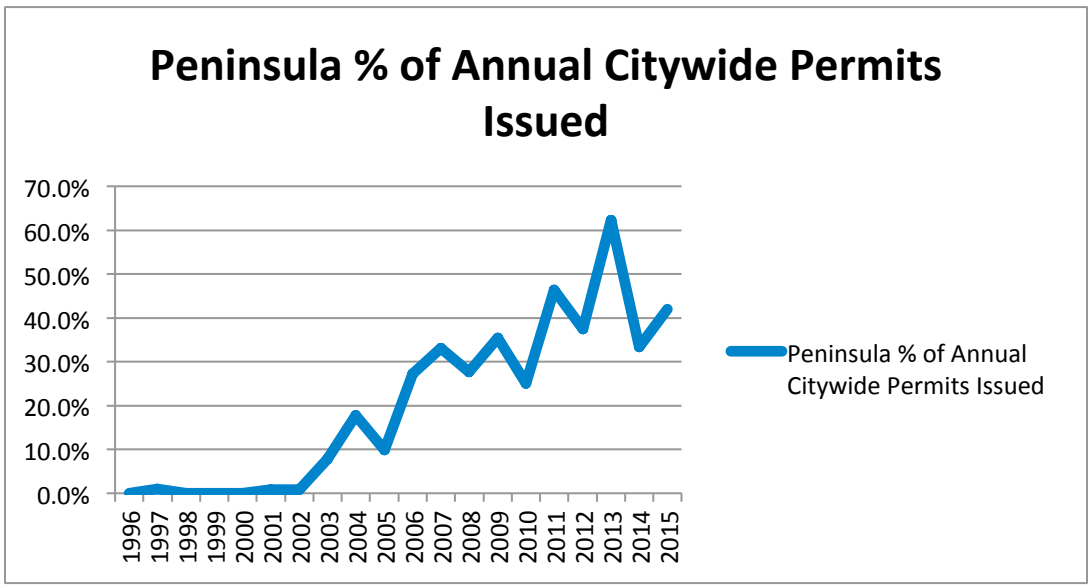
A 1999 study concluded that for 194 homes with swimming pools, the addition of a swimming pool increased demand for water between 22 to 25 percent. It was observed the Peninsula area has seen a dramatic increase in the installation of pools since 1996*.

Year	Total Peninsula Pools Permits	Total City Pool Permits	Peninsula % of Pools in City	Peninsula % of Annual Citywide Permits Issued
1996	0	59	0%	0.0%
2015	297	1881	16%	41.9%

Representing only about 8% of residential water accounts, the Peninsula area contributes to 16% of all pool installations since 1996.







*** The City implemented the Sungard HTE/Naviline utility billing software in 1995/1996. As such, pool permits data is available only from 1996 going forward.**

5.4 Irrigation Permits – Peninsula vs. Citywide

<u>Procedures</u>:

c. **Review data from the City's utility billing software for irrigation permit records for the City and Peninsula area.**
d. **Trace analytical data to the City's detail records.**

Results:

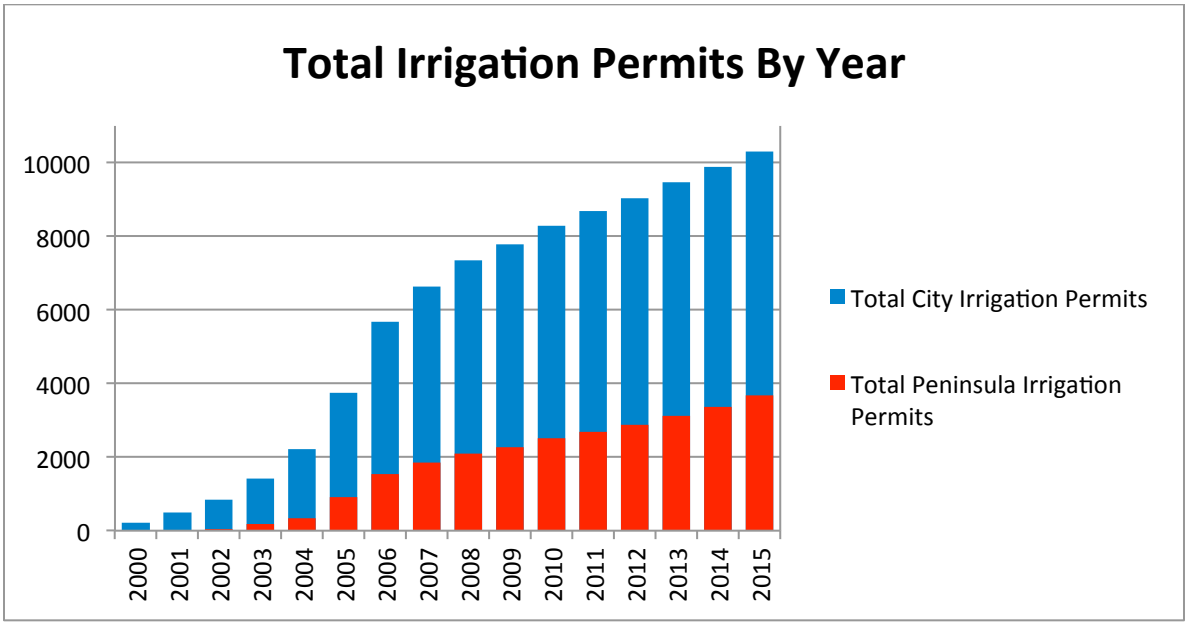
c. **See Appendix 6.10 for analytical data on Peninsula irrigation permits as a percentage of citywide pool permits.**
d. **All analytical data was traced to detail documentation from the City's utility billing software.**

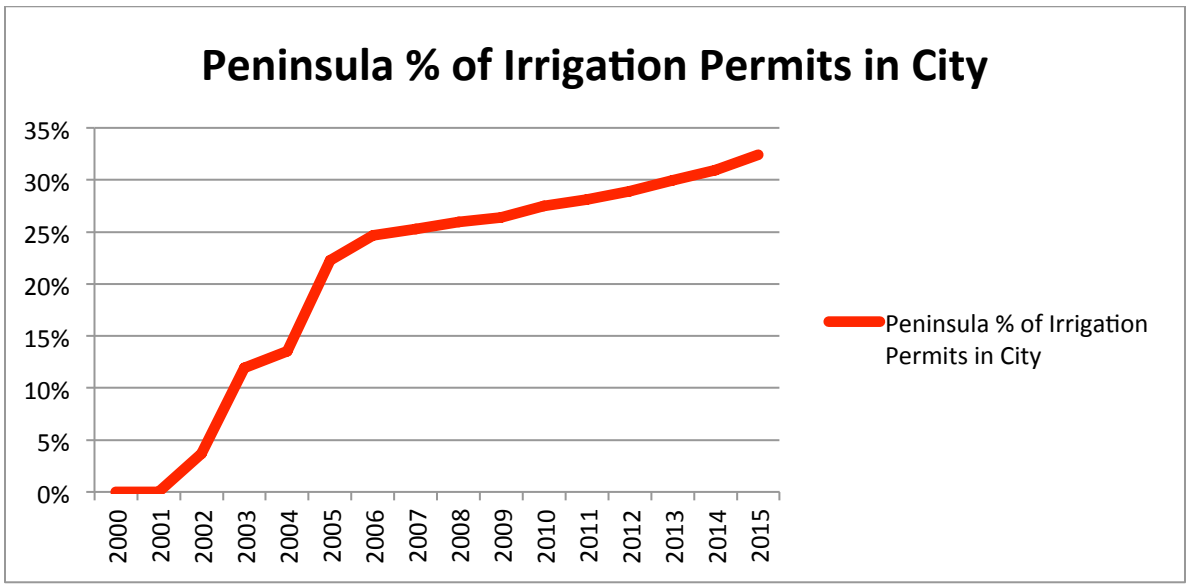
General Observations:

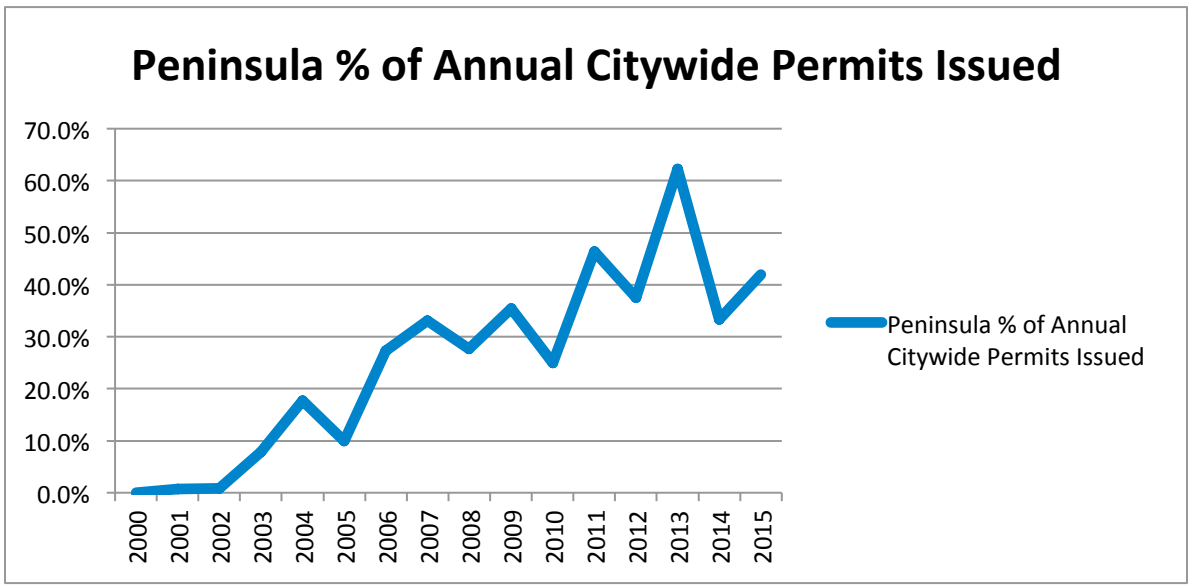
As noted before, a 1999 study concluded the addition of an automatic sprinkler system increased water demand between 54.9 to 60.6 percent over residents who did not have automatic sprinkler systems. It was observed the Peninsula area has seen a dramatic increase in the installation of automatic sprinkler systems since 2000*.

Year	Total Peninsula Irrigations Permits	Total City Irrigation Permits	Peninsula % of Irrigations in City	Peninsula % of Annual Citywide Permits Issued
2000	0	211	0%	0.0%
2015	3344	10310	32%	41.9%

Representing only about 8% of residential water accounts, the Peninsula area contributed to 32% of all irrigation installations since 2000.





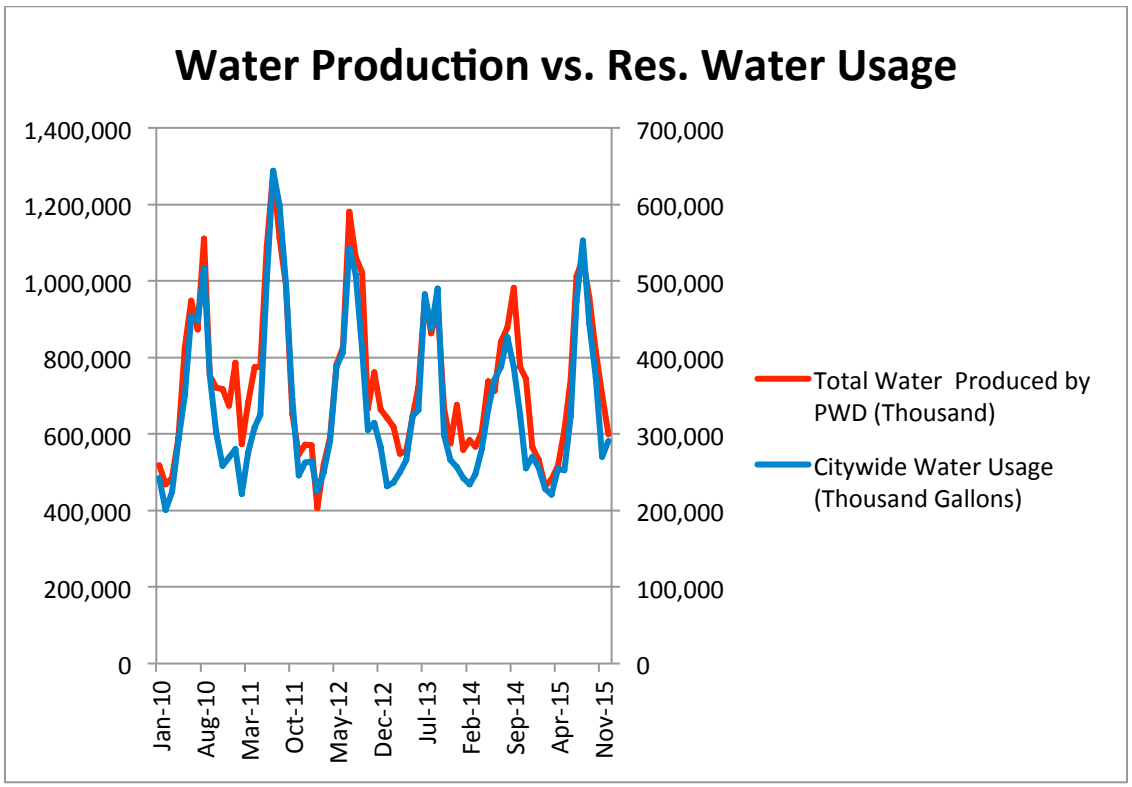


*** The City implemented the Sungard HTE/Naviline utility billing software in 1995/1996. The City began tracking irrigation permits separately from plumbing permits only in 2000. As such, the review period is from 2000 to 2015.**

5.5 Data on Total Water Bills and Water Pumped

Procedures: Review the total residential consumption and total water pumped.

Results: Water production by the PWD (thousands of gallons) and water usage by residential customers citywide.



General Observation: Total water production includes water pumped/produced for all uses (residential, commercial, industrial, and governmental). Water is produced as necessary to provide the entire water system (water towers, storage tanks, pumps, etc.) enough to meet demand. Residential water usage demand is roughly half of total water system demand.

It appears that when there is higher residential customer usage, more water is being pumped and being accounted for.

6.0 APPENDICES

6.1 Water Charges Recalculation

	Minimum Base Fee			Total Variable Fee Naviline			Consumption Naviline (thousands)			Calculated Tier Pricing			Calculated Total Variable Fee			Difference		
LocID	Calculated Minimum Consumption Charge	Amount Charged in June, July, August	Difference	June	July	Aug	June	July	Aug	June	July	Aug	June	July	Aug	June	July	Aug
95237	$12.51	$12.51	0	$17.85	$17.85	$35.70	5	5	10	$3.57	$3.57	$3.57	$17.85	$17.85	$35.70	0	0	0
95261	$12.51	$12.51	0	$46.41	$83.68	$95.96	13	22	24	$3.57	$6.14	$6.14	$46.41	$83.68	$95.96	0	0	0
95393	$12.51	$12.51	0	$28.56	$49.98	$138.94	8	14	31	$3.57	$3.57	$6.14	$28.56	$49.98	$138.94	0	0	0
95405	$12.51	$12.51	0	$0.12	$14.28	$21.42	1	4	6	$0.12	$3.57	$3.57	$0.12	$14.28	$21.42	0	0	0
95407	$12.51	$12.51	0	n/a	$0.36	$0.36	n/a	3	3	n/a	$0.12	$0.12	n/a	$0.36	$0.36	n/a	0	0
95541	$12.51	$12.51	0	$17.85	$21.42	$49.98	5	6	14	$3.57	$3.57	$3.57	$17.85	$21.42	$49.98	0	0	0
95585	$12.51	$12.51	0	$0.36	$14.28	$46.41	3	4	13	$0.12	$3.57	$3.57	$0.36	$14.28	$46.41	0	0	0
95751	$12.51	$12.51	0	$17.85	$14.28	$21.42	5	4	6	$3.57	$3.57	$3.57	$17.85	$14.28	$21.42	0	0	0
98945	$12.51	$12.51	0	$24.99	$60.69	$0.36	7	17	3	$3.57	$3.57	$0.12	$24.99	$60.69	$0.36	0	0	0
99039	$12.51	$12.51	0	$49.98	$53.55	$77.54	14	15	21	$3.57	$3.57	$6.14	$49.98	$53.55	$77.54	0	0	0
101891	$12.51	$12.51	0	$0.36	$17.85	$77.54	3	5	21	$0.12	$3.57	$6.14	$0.36	$17.85	$77.54	0	0	0
104069	$12.51	$12.51	0	$24.99	$35.70	$57.12	7	10	16	$3.57	$3.57	$3.57	$24.99	$35.70	$57.12	0	0	0
104135	$12.51	$12.51	0	$21.42	$24.99	$0.24	6	7	2	$3.57	$3.57	$0.12	$21.42	$24.99	$0.24	0	0	0
105405	$12.51	$12.51	0	$60.69	$102.10	$77.54	17	25	21	$3.57	$6.14	$6.14	$60.69	$102.10	$77.54	0	0	0
105485	$12.51	$12.51	0	$14.28	$0.36	$0.24	4	3	2	$3.57	$0.12	$0.12	$14.28	$0.36	$0.24	0	0	0
105699	$12.51	$12.51	0	$14.28	$28.56	$53.55	4	8	15	$3.57	$3.57	$3.57	$14.28	$28.56	$53.55	0	0	0
107545	$12.51	$12.51	0	$14.28	$32.13	$35.70	4	9	10	$3.57	$3.57	$3.57	$14.28	$32.13	$35.70	0	0	0
107571	$12.51	$12.51	0	$14.28	$0.24	$0.12	4	2	1	$3.57	$0.12	$0.12	$14.28	$0.24	$0.12	0	0	0
107573	$12.51	$12.51	0	$0.36	$0.36	$0.36	3	3	3	$0.12	$0.12	$0.12	$0.36	$0.36	$0.36	0	0	0
107615	$12.51	$12.51	0	$21.42	$49.98	$46.41	6	14	13	$3.57	$3.57	$3.57	$21.42	$49.98	$46.41	0	0	0
107691	$12.51	$12.51	0	$49.98	$89.82	$255.60	14	23	50	$3.57	$6.14	$6.14	$49.98	$89.82	$255.60	0	0	0
107743	$12.51	$12.51	0	$46.41	$67.83	$77.54	13	19	21	$3.57	$3.57	$6.14	$46.41	$67.83	$77.54	0	0	0
107769	$12.51	$12.51	0	$14.28	$28.56	$57.12	4	8	16	$3.57	$3.57	$3.57	$14.28	$28.56	$57.12	0	0	0
107893	$12.51	$12.51	0	$35.70	$57.12	$89.82	10	16	23	$3.57	$3.57	$6.14	$35.70	$57.12	$89.82	0	0	0
109413	$12.51	$12.51	0	$0.24	$0.36	$0.36	2	3	3	$0.12	$0.12	$0.12	$0.24	$0.36	$0.36	0	0	0
109557	$12.51	$12.51	0	$0.12	$17.85	$49.98	1	5	14	$0.12	$3.57	$3.57	$0.12	$17.85	$49.98	0	0	0
109603	$12.51	$12.51	0	$0.24	$17.85	$0.12	2	5	1	$0.12	$3.57	$0.12	$0.24	$17.85	$0.12	0	0	0
109669	$12.51	$12.51	0	$14.28	$17.85	$0.36	4	5	3	$3.57	$3.57	$0.12	$14.28	$17.85	$0.36	0	0	0
110617	$12.51	$12.51	0	$24.99	$49.98	$60.69	7	14	17	$3.57	$3.57	$3.57	$24.99	$49.98	$60.69	0	0	0
113939	$12.51	$12.51	0	$21.42	$32.13	$42.84	6	9	12	$3.57	$3.57	$3.57	$21.42	$32.13	$42.84	0	0	0
114297	$12.51	$12.51	0	$17.85	$17.85	$17.85	5	5	5	$3.57	$3.57	$3.57	$17.85	$17.85	$17.85	0	0	0
114361	$12.51	$12.51	0	$35.70	$24.99	$67.83	10	7	19	$3.57	$3.57	$3.57	$35.70	$24.99	$67.83	0	0	0
116547	$12.51	$12.51	0	$53.55	$21.42	$181.92	15	6	38	$3.57	$3.57	$6.14	$53.55	$21.42	$181.92	0	0	0
116583	$12.51	$12.51	0	$67.83	$64.26	$46.41	19	18	13	$3.57	$3.57	$3.57	$67.83	$64.26	$46.41	0	0	0
117985	$12.51	$12.51	0	$14.28	$24.99	$95.96	4	7	24	$3.57	$3.57	$6.14	$14.28	$24.99	$95.96	0	0	0
118007	$12.51	$12.51	0	$14.28	$32.13	$77.54	4	9	21	$3.57	$3.57	$6.14	$14.28	$32.13	$77.54	0	0	0
119855	$12.51	$12.51	0	$46.41	$64.26	$89.82	13	18	23	$3.57	$3.57	$6.14	$46.41	$64.26	$89.82	0	0	0
119881	$12.51	$12.51	0	$42.84	$60.69	$126.66	12	17	29	$3.57	$3.57	$6.14	$42.84	$60.69	$126.66	0	0	0
119897	$12.51	$12.51	0	$57.12	$42.84	$53.55	16	12	15	$3.57	$3.57	$3.57	$57.12	$42.84	$53.55	0	0	0
120225	$12.51	$12.51	0	$95.96	$95.96	$163.50	24	24	35	$6.14	$6.14	$6.14	$95.96	$95.96	$163.50	0	0	0
121385	$12.51	$12.51	0	$17.85	$21.42	$89.82	5	6	23	$3.57	$3.57	$6.14	$17.85	$21.42	$89.82	0	0	0
121439	$12.51	$12.51	0	$188.06	$169.64	$108.24	39	36	26	$6.14	$6.14	$6.14	$188.06	$169.64	$108.24	0	0	0
121451	$12.51	$12.51	0	$0.36	$39.27	$224.90	3	11	45	$0.12	$3.57	$6.14	$0.36	$39.27	$224.90	0	0	0
121771	$12.51	$12.51	0	$49.98	$60.69	$64.26	14	17	18	$3.57	$3.57	$3.57	$49.98	$60.69	$64.26	0	0	0
122037	$12.51	$12.51	0	$120.52	$64.26	$175.78	28	18	37	$6.14	$3.57	$6.14	$120.52	$64.26	$175.78	0	0	0
124807	$12.51	$12.51	0	$32.13	$39.27	$42.84	9	11	12	$3.57	$3.57	$3.57	$32.13	$39.27	$42.84	0	0	0
126099	$12.51	$12.51	0	$46.41	$21.42	$53.55	13	6	15	$3.57	$3.57	$3.57	$46.41	$21.42	$53.55	0	0	0
126115	$12.51	$12.51	0	$14.28	$14.28	$0.36	4	4	3	$3.57	$3.57	$0.12	$14.28	$14.28	$0.36	0	0	0
126929	$12.51	$12.51	0	$60.69	$60.69	$95.96	17	17	24	$3.57	$3.57	$6.14	$60.69	$60.69	$95.96	0	0	0
127363	$12.51	$12.51	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

*NOTE: n/a indicates there was not a utility bill to recalculate since the billing location was not setup/active during the reviewed time period

6.2 Waterwater Charges Recalculation

	Days Between Meter Readings				2015 Usage (thousands)										
LocID	Nov.	Dec.	Jan.	Feb.	Nov.	Dec.	Jan.	Feb.	Highest Consumption Month	3 Month Usage Total (thousands)	Days Total	Per Day Usage	Calculated Winter Month Avg (thousands)	Actual Billed WW (thousands)	Difference
95237	28	32	36	31	5	7	6	6	December	17	95	0.18	5.48	5.48	0
95261	28	32	36	31	28	8	6	7	November	21	99	0.21	6.39	6.39	0
95393	28	32	36	31	8	5	7	6	November	18	99	0.18	5.48	5.48	0
95405	28	32	36	31	6	3	5	2	November	10	99	0.1	3.04	3.04	0
95407	28	32	36	31	1	2	3	1	January	4	91	0.04	1.22	1.22	0
95541	28	32	36	31	6	6	6	5	November	17	99	0.17	5.17	5.17	0
95585	28	32	36	31	9	10	7	7	December	23	95	0.24	7.3	7.3	0
95751	29	32	36	30	12	8	5	3	November	16	98	0.16	4.87	4.87	0
98945	28	32	36	31	3	4	3	3	December	9	95	0.09	2.74	2.74	0
99039	28	32	36	28	15	10	9	5	November	24	96	0.25	7.61	7.61	0
101891	28	32	36	31	5	4	6	5	January	14	91	0.15	4.56	4.56	0
104069	28	32	36	31	5	8	9	7	January	20	91	0.22	6.69	6.69	0
104135	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	80%
105405	28	32	36	31	20	24	18	8	December	46	95	0.48	14.6	14.6	0
105485	28	32	36	31	3	3	5	3	January	9	91	0.1	3.04	3.04	0
105699	32	36	31	28	6	6	6	4	December	16	91	0.18	5.48	5.48	0
107545	28	32	36	31	5	5	5	5	November	15	99	0.15	4.56	4.56	0
107571	32	36	31	28	7	4	6	6	November	16	95	0.17	5.17	5.17	0
107573	28	32	36	31	4	4	5	3	January	11	91	0.12	3.65	3.65	0
107615	28	32	36	31	9	6	6	5	November	17	99	0.17	5.17	5.17	0
107691	28	32	36	30	22	9	7	8	November	24	98	0.24	7.3	7.3	0
107743	28	32	36	31	16	6	3	3	November	12	99	0.12	3.65	3.65	0
107769	28	32	36	31	4	4	5	5	January	13	91	0.14	4.26	4.26	0
107893	28	32	36	31	19	12	7	7	November	26	99	0.26	7.91	7.91	0
109413	28	32	36	31	4	5	3	2	December	9	95	0.09	2.74	2.74	0
109557	32	36	31	28	3	3	1	2	December	6	91	0.07	2.13	2.13	0
109603	28	32	36	31	1	4	1	1	December	3	95	0.03	0.91	0.91	0
109669	28	32	36	31	5	9	5	5	December	15	95	0.16	4.87	4.87	0
110617	28	32	36	31	13	5	5	6	November	16	99	0.16	4.87	4.87	0
113939	28	32	36	31	8	6	7	9	February	21	96	0.22	6.69	6.69	0
114297	28	32	36	31	2	4	4	3	December	9	95	0.09	2.74	2.74	0
114361	32	36	31	28	4	5	4	4	December	12	91	0.13	3.95	3.95	0
116547	28	32	36	31	5	6	7	6	January	17	91	0.19	5.78	5.78	0
116583	28	32	36	31	14	8	10	9	November	27	99	0.27	8.21	8.21	0
117985	28	32	36	31	23	5	5	4	November	14	99	0.14	4.26	4.26	0
118007	28	32	36	31	11	11	5	1	November	17	99	0.17	5.17	5.17	0
119855	32	36	31	28	6	8	7	8	February	21	99	0.21	6.39	6.39	0
119881	28	32	36	31	12	15	15	14	December	41	95	0.43	13.08	13.08	0
119897	28	32	36	7	11	2	1	1	November	4	75	0.05	1.52	1.52	0
120225	28	32	36	31	10	11	10	11	December	31	95	0.33	10.04	10.04	0
121385	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	15	12k Cap
121439	28	32	36	31	4	4	7	3	January	11	91	0.12	3.65	3.65	0
121451	32	36	31	28	3	3	2	3	February	8	99	0.08	2.43	2.43	0
121771	13	36	31	28	1	5	9	10	February	15	80	0.19	5.78	5.78	0
122037	32	36	31	28	3	4	4	3	January	10	96	0.1	3.04	3.04	0
124807	28	32	36	31	13	14	7	11	December	31	95	0.33	10.04	10.04	0
126099	32	36	31	28	9	9	7	8	November	24	95	0.25	7.61	7.61	0
126115	32	36	31	28	4	4	3	3	November	10	95	0.11	3.35	3.35	0
126929	28	32	36	31	15	18	16	8	December	39	95	0.41	12.47	12.47	0
127363	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	15	12k Cap

6.3 Garbage/Recycling & Garbage Taxes Recalculations

LocID	Calculated Trash & Recycle Services	Amount Charged in June, July, August	Difference	Calculated Trash & Recycle Services Taxes	Amount Charged in June, July, August	Difference
95237	$14.38	$14.38	0	$1.19	$1.19	0
95261	$14.38	$14.38	0	$1.19	$1.19	0
95393	$14.38	$14.38	0	$1.19	$1.19	0
95405	$14.38	$14.38	0	$1.19	$1.19	0
95407	$14.38	$14.38	0	$1.19	$1.19	0
95541	$14.38	$14.38	0	$1.19	$1.19	0
95585	$13.38	$13.38	0	$1.10	$1.10	0
95751	$14.38	$14.38	0	$1.19	$1.19	0
98945	$14.38	$14.38	0	$1.19	$1.19	0
99039	$14.38	$14.38	0	$1.19	$1.19	0
101891	$14.38	$14.38	0	$1.19	$1.19	0
104069	$14.38	$14.38	0	$1.19	$1.19	0
104135	$14.38	$14.38	0	$1.19	$1.19	0
105405	$14.38	$14.38	0	$1.19	$1.19	0
105485	$14.38	$14.38	0	$1.19	$1.19	0
105699	$14.38	$14.38	0	$1.19	$1.19	0
107545	$14.38	$14.38	0	$1.19	$1.19	0
107571	$14.38	$14.38	0	$1.19	$1.19	0
107573	$14.38	$14.38	0	$1.19	$1.19	0
107615	$14.38	$14.38	0	$1.19	$1.19	0
107691	$14.38	$14.38	0	$1.19	$1.19	0
107743	$14.38	$14.38	0	$1.19	$1.19	0
107769	$14.38	$14.38	0	$1.19	$1.19	0
107893	$14.38	$14.38	0	$1.19	$1.19	0
109413	$14.38	$14.38	0	$1.19	$1.19	0
109557	$14.38	$14.38	0	$1.19	$1.19	0
109603	$14.38	$14.38	0	$1.19	$1.19	0
109669	$14.38	$14.38	0	$1.19	$1.19	0
110617	$14.38	$14.38	0	$1.19	$1.19	0
113939	$14.38	$14.38	0	$1.19	$1.19	0
114297	$14.38	$14.38	0	$1.19	$1.19	0
114361	$14.38	$14.38	0	$1.19	$1.19	0
116547	$14.38	$14.38	0	$1.19	$1.19	0
116583	$14.38	$14.38	0	$1.19	$1.19	0
117985	$14.38	$14.38	0	$1.19	$1.19	0
118007	$14.38	$14.38	0	$1.19	$1.19	0
119855	$14.38	$14.38	0	$1.19	$1.19	0
119881	$14.38	$14.38	0	$1.19	$1.19	0
119897	$14.38	$14.38	0	$1.19	$1.19	0
120225	$14.38	$14.38	0	$1.19	$1.19	0
121385	$14.38	$14.38	0	$1.19	$1.19	0
121439	$14.38	$14.38	0	$1.19	$1.19	0
121451	$14.38	$14.38	0	$1.19	$1.19	0
121771	$14.38	$14.38	0	$1.19	$1.19	0
122037	$14.38	$14.38	0	$1.19	$1.19	0
124807	$14.38	$14.38	0	$1.19	$1.19	0
126099	$14.38	$14.38	0	$1.19	$1.19	0
126115	$14.38	$14.38	0	$1.19	$1.19	0
126929	$14.38	$14.38	0	$1.19	$1.19	0
127363	$14.38	$14.38	0	$1.19	$1.19	0

6.4 Storm Drainage Fee Recalculation

	LocID	Totals Square Footage	Total Living Area	1st Foor Sq. Ft.	Garage Sq. Ft.	Porch/Patio Sq. Ft.	Storage Sq. Ft.	Other Sq. Ft.	Total Impervious Sq. Ft.	Calculated Storm Drainage Fee	Amount Charged in June, July, August	Difference
1	126099	5,539	4,338	2,503	771	430	-	-	3,704	$4.35	$4.35	0
2	126115	4,508	3,883	2,262	482	143	-	-	2,887	$4.35	$4.35	0
3	119881	4,122	3,523	1,978	452	147	-	-	2,577	$4.35	$4.35	0
4	119855	4,122	3,523	1,978	452	147	-	-	2,577	$4.35	$4.35	0
5	107691	4,345	3,610	2,435	572	163	-	-	3,170	$4.35	$4.35	0
6	107893	4,332	3,500	1,963	716	16	-	-	2,695	$4.35	$4.35	0
7	124807	3,219	2,583	2,583	503	133	-	-	3,219	$4.35	$4.35	0
8	107545	2,617	2,098	2,098	443	76	-	-	2,617	$4.35	$4.35	0
9	118007	5,472	4,608	2,503	594	270	-	-	3,367	$4.35	$4.35	0
10	126929	7,277	5,704	3,308	731	842	-	-	4,881	$4.35	$4.35	0
11	117985	4,831	4,140	2,490	664	27	-	-	3,181	$4.35	$4.35	0
12	114297	2,979	2,323	2,323	507	149	-	`	2,979	$4.35	$4.35	0
13	104069	2,262	1,819	1,819	429	14	-	-	2,262	$3.76	$3.76	0
14	113939	4,425	3,958	2,361	442	25	-	-	2,828	$4.35	$4.35	0
15	95585	2,548	2,114	2,114	408	26	-	-	2,548	$4.35	$4.35	0
16	95237	4,189	3,532	2,218	657	-	-	-	2,875	$4.35	$4.35	0
17	95405	2,455	2,012	2,012	423	20	-	-	2,455	$3.76	$3.76	0
18	95407	2,658	2,215	2,215	415	28	-	-	2,658	$4.35	$3.76	0.59
19	95393	2,931	2,556	1,850	427	41	-	-	2,318	$4.35*	$4.35	0
20	95261	3,366	2,854	2,544	381	131	-	-	3,056	$4.35	$4.35	0
21	99039	4,368	3,691	2,053	648	29	-	-	2,730	$4.35	$4.35	0
22	95541	2,393	1,950	1,825	411	31	-	-	2,267	$3.76	$3.76	0
23	101891	3,593	2,946	1,911	462	185	-	-	2,558	$4.35	$4.35	0
24	107615	3,216	2,746	1,646	412	58	-	-	2,116	$3.76	$3.76	0
25	116583	3,064	2,556	1,606	433	75	-	-	2,114	$3.76	$3.76	0
26	120225	2,747	4,094	2,324	611	1,042	-	-	3,977	$4.35	$4.35	0
27	98945	3,412	2,914	1,787	415	89	-	-	2,291	$4.35*	$4.35	0
28	122037	4,214	3,603	1,999	443	168	-	-	2,610	$4.35	$4.35	0
29	119897	5,572	4,466	2,385	794	312	-	-	3,491	$4.35	$4.35	0
30	105405	4,233	3,551	2,286	571	313	-	-	3,170	$4.35	$4.35	0
31	114361	3,778	3,076	1,667	620	82	-	-	2,369	$3.76	$3.76	0
32	109669	3,225	2,579	1,674	408	238	-	-	2,320	$3.76	$3.76	0
33	105699	3,186	2,596	1,280	557	33	-	-	1,870	$3.76	$3.76	0
34	107769	3,381	2,894	2,249	456	31	-	-	2,736	$4.35	$4.35	0
35	109413	2,617	2,180	2,180	459	80	-	-	2,719	$4.35	$4.35	0
36	105485	2,554	2,085	2,085	442	27	-	-	2,554	$4.35	$4.35	0
37	95751	3,399	2,955	1,918	444	-	-	-	2,362	$4.35*	$4.35	0
38	121771	4,656	3,810	2,388	618	228	-	-	3,234	$4.35	$4.35	0
39	109557	3,586	2,863	1,756	442	281	-	-	2,479	$4.35*	$4.35	0
40	109603	2,719	2,180	2,180	459	80	-	-	2,719	$4.35	$4.35	0
41	110617	4,702	3,944	2,375	642	116	-	-	3,133	$4.35	$4.35	0
42	127363	2,951	2,208	2,555	450	234	-	-	3,239	$4.35	$4.35	0
43	121439	4,312	3,445	1,698	719	154	-	-	2,571	$4.35	$4.35	0
44	121451	5,009	4,181	2,478	617	211	-	-	3,306	$4.35	$4.35	0
45	121385	4,001	3,354	2,186	448	199	-	-	2,833	$4.35	$4.35	0
46	107571	2,646	2,203	2,203	415	28	-	-	2,646	$4.35	$4.35	0
47	107573	2,561	2,126	2,126	409	26	-	-	2,561	$4.35	$4.35	0
48	116547	2,563	2,128	2,128	409	26	-	-	2,563	$4.35	$4.35	0
49	107743	3,450	2,883	2,238	456	111	-	-	2,805	$4.35	$4.35	0
50	104135	2,486	2,036	2,036	423	27	-	-	2,486	$3.76	$3.76	0

*NOTE: Homes built prior to approximately 2006 where charged based on the total square footage of the house. Home built subsequently were assessed based on impervious square footage.

6.5 ERT vs. Manual Readings

		Read at Residence		
Location ID	Register Serial Number	FC300 Meter Read (tens)	Manual Register Read (tens)	Difference
95405	70355	45,429	45,430	-1
95407	48819	102,921	102,922	-1
95393	70360	168,176	168,177	-1
95261	48203	239,145	239,145	0
99039	59108	198,895	198,895	0
101891	53839	113,612	113,613	-1
98945	48974	105,416	105,414	2
107743	65465	207,699	207,700	-1
107691	64346	236,725	236,726	-1
107893	64764	225,719	225,720	-1
107545	66849	89,612	89,612	0
107571	63849	68,448	68,448	0
107573	63769	97,886	97,887	-1
121451	70302	137,142	137,142	0
121385	76436	81,859	81,859	0
114361	69912	102,853	102,854	-1
114297	79712	47,154	47,154	0
113939	65527	97,986	97,986	0
116547	64834	135,587	135,588	-1
121439	77683	67,604	67,604	0
105485	63053	65,886	65,887	-1
105699	61983	134,130	134,130	0
126099	81856	34,621	34,621	0
119881	74032	95,326	95,326	0
118007	73882	78,557	78,550	7
126115	81753	24,240	24,240	0
119855	69772	159,426	159,427	-1
126929	81071	41,964	41,965	-1
117985	69091	189,246	189,246	0
109413	65025	102,252	102,252	0
109557	61962	140,195	140,196	-1
109669	63158	105,591	105,592	-1
120225	76275	109,436	109,436	0
109603	63370	57,526	57,526	0
104069	62644	104,608	104,608	0
104135	58539	77,657	77,657	0
95237	48146	No Signal	229,755	N/A
95541	48462	89,531	89,532	-1
95751	48856	203,436	203,436	0
95585	70367	110,475	110,475	0
121771	14667859	18,280	18,280	0
107769	64146	108,831	108,832	-1
122037	78497	55,974	55,975	-1
107615	63799	111,298	111,298	0
119897	71446	98,079	98,079	0
105405	69329	154,416	154,416	0
116583	69751	No Signal	123,527	N/A
110617	69827	155,809	155,810	-1
124807	80751	37,920	37,920	0
127363	82496	11,495	11,496	-1

6.6 ERT vs. MV-RS

Location ID	FC300 Read (tens)	FC300 Read Trunc (thousands)	MV-RS (thousands)	Difference
95237	No Signal	No Signal	2,298	Not Applicable
95261	239,145	2,391	2,391	0
95393	168,176	1,681	1,681	0
95405	45,429	454	454	0
95407	102,921	1,029	1,029	0
95541	89,531	895	895	0
95585	110,475	1,104	1,104	0
95751	203,436	2,034	2,034	0
98945	105,416	1,054	1,054	0
99039	198,895	1,988	1,988	0
101891	113,612	1,136	1,136	0
104069	92,012	920	920	0
104135	77,657	776	776	0
105405	154,416	1,544	1,544	0
105485	65,886	658	658	0
105699	134,130	1,341	1,341	0
107545	89,612	896	896	0
107571	68,448	684	684	0
107573	97,886	978	978	0
107615	111,298	1,112	1,113	-1
107691	236,725	2,367	2,367	0
107743	207,699	2,076	2,076	0
107769	108,831	1,088	1,088	0
107893	225,719	2,257	2,257	0
109413	102,252	1,022	1,022	0
109557	140,195	1,401	1,401	0
109603	57,526	575	575	0
109669	105,591	1,055	1,055	0
110617	155,809	1,558	1,558	0
113939	97,986	979	979	0
114297	47,154	471	471	0
114361	102,853	1,028	1,028	0
116547	135,587	1,355	1,355	0
116583	No Signal	No Signal	1,235	Not Applicable
117985	189,246	1,892	1,892	0
118007	78,557	785	785	0
119855	159,426	1,594	1,594	0
119881	95,326	953	953	0
119897	98,079	980	980	0
120225	109,436	1,094	1,094	0
121385	81,859	818	818	0
121439	67,604	676	676	0
121451	137,142	1,371	1,371	0
121771	18,280	182	182	0
122037	55,974	559	559	0
124807	37,920	379	379	0
126099	34,621	346	346	0
126115	24,240	242	242	0
126929	41,964	419	419	0
127363	11,495	114	114	0

6.7 Independent Meter Test Results

Southern Flowmeter, Inc.
Fast-Reliable-Accurate
(281) 977-5544

Customer Same as Owner
District Grand Prarie, City of
Date 2/4/2016

Serial	Si	Brand	Model	Reg 1	Reg 2	Low %	Mid %	High %	WA	Date
14667859	5/8	Badger	25	188275.8	0	101.00%	101.50%	101.20%	101.38%	Friday, January 29, 2016
48146	5/8	Badger	25	2301666.1	0	98.00%	100.00%	98.33%	99.45%	Friday, January 29, 2016
48203	5/8	Badger	25	2395489.5	0	98.00%	101.00%	98.80%	100.22%	Saturday, January 30, 2016
48462	5/8	Badger	25	899401.4	0	99.00%	99.50%	99.67%	99.45%	Friday, January 29, 2016
48819	5/8	Elster Amco	Positive Displacement	1031507.9	0	101.00%	100.50%	100.47%	100.57%	Friday, January 29, 2016
48856	5/8	Elster Amco	Positive Displacement	2036552.3	0	92.00%	101.00%	100.80%	99.62%	Friday, January 29, 2016
48974	5/8	Elster Amco	Positive Displacement	1057237.7	0	101.00%	101.50%	100.47%	101.27%	Friday, January 29, 2016
49931	5/8	Elster Amco	Positive Displacement	1504618.2	0	98.00%	100.50%	100.13%	100.07%	Friday, January 29, 2016
53839	5/8	Badger	25	1138166.9	0	98.00%	99.50%	98.73%	99.16%	Friday, January 29, 2016
58539	5/8	Badger	25	778003.7	0	100.00%	100.00%	99.73%	99.96%	Saturday, January 30, 2016
59108	5/8	Badger	25	1994573.7	0	99.00%	99.50%	100.13%	99.52%	Friday, January 29, 2016
61775	5/8	Badger	25	925506.1	0	99.00%	99.50%	98.67%	99.30%	Friday, January 29, 2016
61962	5/8	Badger	25	1402000	0	99.00%	101.00%	99.40%	100.46%	Friday, January 29, 2016
61982	5/8	Badger	25	1897464.7	0	98.00%	101.00%	98.87%	100.23%	Friday, January 29, 2016
61983	5/8	Badger	25	1344904.2	0	100.00%	100.00%	100.07%	100.01%	Friday, January 29, 2016
63053	5/8	Badger	25	661161.5	0	102.00%	100.00%	99.93%	100.29%	Friday, January 29, 2016
63067	5/8	Badger	25	1430237.4	0	101.00%	101.50%	101.00%	101.35%	Friday, January 29, 2016
63158	5/8	Badger	25	1058323.6	0	101.00%	100.50%	100.67%	100.60%	Friday, January 29, 2016
63370	5/8	Badger	25	575601.3	0	99.00%	101.00%	100.67%	100.65%	Friday, January 29, 2016
63769	5/8	Badger	25	981510	0	100.00%	100.00%	100.07%	100.01%	Sunday, January 31, 2016
63799	5/8	Badger	25	1117893.8	0	98.00%	99.00%	99.40%	98.91%	Saturday, January 30, 2016
63849	5/8	Badger	25	690219.6	0	96.00%	100.50%	99.80%	99.72%	Saturday, January 30, 2016
64146	5/8	Badger	25	1091085.2	0	99.00%	99.50%	100.20%	99.53%	Saturday, January 30, 2016
64346	5/8	Badger	25	2373830.5	0	100.00%	100.00%	100.00%	100.00%	Saturday, January 30, 2016
64764	5/8	Badger	25	2262266	0	98.00%	99.50%	98.53%	99.13%	Saturday, January 31, 2015
64834	5/8	Badger	25	1362300	0	100.00%	99.00%	99.27%	99.19%	Friday, January 29, 2016
65025	5/8	Badger	25	1023810	0	101.00%	100.00%	99.80%	100.12%	Saturday, January 30, 2016
65465	5/8	Badger	25	2079017.1	0	100.00%	99.50%	99.00%	99.50%	Friday, January 29, 2016
65527	5/8	Badger	25	983643.1	0	101.00%	100.50%	100.00%	100.50%	Friday, January 29, 2016
66849	5/8	Badger	25	899725.4	0	101.00%	100.00%	100.00%	100.15%	Saturday, January 30, 2016
68637	5/8	Badger	25	780266.7	0	101.00%	100.00%	100.93%	100.29%	Friday, January 29, 2016
69091	5/8	Badger	25	1895998.8	0	98.00%	98.00%	96.93%	97.84%	Friday, January 29, 2016
69329	5/8	Badger	25	1553281.6	0	99.00%	100.00%	99.20%	99.73%	Friday, January 29, 2016
69751	5/8	Badger	25	1242739.6	0	99.00%	99.00%	98.87%	98.98%	Friday, January 29, 2016
69772	5/8	Badger	25	1603810.5	0	100.00%	99.50%	98.73%	99.46%	Friday, January 29, 2016
69827	5/8	Badger	25	1560962.3	0	98.00%	98.00%	98.20%	98.03%	Friday, January 29, 2016
69912	5/8	Badger	25	1034303.9	0	100.00%	100.00%	100.00%	100.00%	Friday, January 29, 2016
70302	5/8	Badger	25	13736686	0	99.00%	99.00%	99.53%	99.08%	Saturday, January 30, 2016
70355	5/8	Badger	25	461036.6	0	101.00%	101.50%	100.07%	101.21%	Friday, January 29, 2016
70360	5/8	Badger	25	1685396.4	0	99.00%	99.50%	99.87%	99.48%	Friday, January 29, 2016
70367	5/8	Badger	25	1106674.1	0	101.00%	101.00%	100.27%	100.89%	Friday, January 29, 2016
71446	5/8	Badger	25	983447.9	0	100.00%	100.50%	98.87%	100.18%	Sunday, January 31, 2016
73882	5/8	Badger	25	797407.5	0	99.00%	99.50%	99.60%	99.44%	Saturday, January 30, 2016
74032	5/8	Badger	25	964919.6	0	99.00%	100.00%	100.00%	99.85%	Saturday, January 30, 2016
76275	5/8	Badger	25	1101153.1		98.00%	100.50%	99.80%	100.02%	Saturday, January 30, 2016
76436	5/8	Badger	25	838911.7	0	100.00%	100.00%	99.80%	99.97%	Saturday, January 30, 2016
77547	5/8	Badger	25	581335.3	0	102.00%	101.00%	100.20%	101.03%	Friday, January 29, 2016
77683	5/8	Badger	25	678507.1	0	101.00%	101.00%	100.20%	100.88%	Friday, January 29, 2016
78497	5/8	Badger	25	561830	0	99.00%	99.50%	99.20%	99.38%	Saturday, January 30, 2016
79712	5/8	Badger	25	474515.2	0	101.00%	101.00%	100.47%	100.92%	Friday, January 29, 2016
80751	5/8	Badger	25	380960.3	0	99.00%	99.50%	99.87%	99.48%	Saturday, January 30, 2016
81071	5/8	Badger	25	428595	0	100.00%	100.50%	100.00%	100.35%	Friday, January 29, 2016
81753	5/8	Badger	25	243972	0	100.00%	100.50%	100.33%	100.40%	Sunday, January 31, 2016
81856	5/8	Badger	25	351725.2	0	98.00%	100.50%	100.47%	100.12%	Friday, January 29, 2016
82496	5/8	Badger	25	118708.9	0	98.00%	100.00%	93.87%	98.78%	Saturday, January 30, 2016

6.8 Water Consumption, Temperature, and Precipitation

Date	Citywide Residential Accounts	Peninsula Residential Accounts	Citywide Water Usage (Thousand Gallons)	Peninsula Water Usage (Thousand Gallons)	Citywide Water Usage (Thousand Gallons) Per Account	Peninsula Water Usage (Thousand Gallons) Per Account	Peninsula % of Total Water Usage	Peninsula % of Total Res. Accts Usage	Max Temp Average (F)	Precipitation (Inches)
Jan-10	41,765	2,348	242,772	13,885	6	6	6%	6%	54	0.63
Feb-10	42,282	2,395	200,528	12,762	5	5	6%	6%	50	0.1
Mar-10	42,138	2,403	224,456	12,242	5	5	5%	6%	67	0.63
Apr-10	42,093	2,403	292,170	22,837	7	10	8%	6%	77	0.83
May-10	42,182	2,401	350,208	24,770	8	10	7%	6%	86	0.19
Jun-10	42,245	2,485	453,851	41,637	11	17	9%	6%	95	0.33
Jul-10	42,287	2,494	447,510	38,759	11	16	9%	6%	94	0.22
Aug-10	42,452	2,519	517,232	47,432	12	19	9%	6%	100	0.03
Sep-10	43,087	2,532	376,712	43,831	9	17	12%	6%	89	1.7
Oct-10	42,156	2,537	302,071	31,229	7	12	10%	6%	81	0
Nov-10	42,406	2,578	258,820	24,283	6	9	9%	6%	69	0.62
Dec-10	42,235	2,579	269,164	18,939	6	7	7%	6%	60	0.52
Jan-11	42,516	2,626	280,073	19,599	7	7	7%	6%	55	0.47
Feb-11	42,855	2,619	221,439	16,691	5	6	8%	6%	61	0.57
Mar-11	42,818	2,626	276,281	20,166	6	8	7%	6%	73	0
Apr-11	43,305	2,623	309,003	30,317	7	12	10%	6%	83	2.12
May-11	43,424	2,711	325,555	30,935	7	11	10%	6%	84	0.87
Jun-11	43,437	2,921	500,211	40,558	12	14	8%	7%	98	0.71
Jul-11	42,931	2,699	644,096	59,767	15	22	9%	6%	102	0
Aug-11	43,786	2,830	599,029	57,231	14	20	10%	6%	104	0.27
Sep-11	43,711	2,710	496,222	53,603	11	20	11%	6%	92	0.12
Oct-11	43,202	2,712	344,245	40,637	8	15	12%	6%	80	1.29
Nov-11	42,775	2,738	246,011	24,696	6	9	10%	6%	68	0.49
Dec-11	42,697	2,708	262,893	17,606	6	7	7%	6%	56	2.24
Jan-12	43,522	2,859	264,229	20,462	6	7	8%	7%	61	3.08
Feb-12	43,451	2,787	224,688	16,794	5	6	7%	6%	61	0.77
Mar-12	44,056	2,860	250,218	18,750	6	7	7%	6%	73	1.82
Apr-12	44,022	2,802	291,063	27,410	7	10	9%	6%	79	0.07
May-12	43,544	2,798	388,373	34,530	9	12	9%	6%	86	0.87
Jun-12	43,511	2,926	406,740	40,543	9	14	10%	7%	92	0.85
Jul-12	43,434	2,846	542,949	49,142	13	17	9%	7%	97	0
Aug-12	43,419	2,958	508,351	59,836	12	20	12%	7%	96	0.62
Sep-12	43,351	2,915	410,829	45,902	9	16	11%	7%	89	0.2
Oct-12	43,027	2,867	305,509	33,267	7	12	11%	7%	76	0.45
Nov-12	43,103	2,897	314,314	31,095	7	11	10%	7%	71	0
Dec-12	43,122	2,929	282,659	29,087	7	10	10%	7%	61	0
Jan-13	42,989	2,924	231,370	17,642	5	6	8%	7%	57	0
Feb-13	43,970	2,970	237,062	19,898	5	7	8%	7%	62	0
Mar-13	44,534	3,175	249,946	21,010	6	7	8%	7%	66	1.73
Apr-13	44,780	3,028	266,191	24,213	6	8	9%	7%	73	1.88
May-13	44,062	3,062	323,912	36,649	7	12	11%	7%	81	0.15
Jun-13	43,286	3,013	331,231	30,417	8	10	9%	7%	91	0.31
Jul-13	44,165	3,118	482,619	48,839	11	16	10%	7%	93	0.3
Aug-13	43,760	3,104	437,097	45,425	10	15	10%	7%	96	0.97
Sep-13	44,249	3,223	489,997	56,089	11	17	11%	7%	91	3.61
Oct-13	43,520	3,099	298,451	39,262	7	13	13%	7%	76	1.19
Nov-13	43,608	3,123	266,016	25,695	6	8	10%	7%	60	1.36
Dec-13	43,626	3,148	256,750	19,228	6	6	7%	7%	53	0.39
Jan-14	43,661	3,234	242,761	19,798	6	6	8%	7%	57	0.02
Feb-14	45,047	3,478	234,014	17,464	5	5	7%	8%	55	0.01
Mar-14	43,945	3,210	247,382	21,003	6	7	8%	7%	66	0.03
Apr-14	44,718	3,224	279,823	27,420	6	9	10%	7%	75	0.12
May-14	44,211	3,304	332,337	36,377	8	11	11%	7%	82	0.3
Jun-14	44,234	3,301	371,374	39,575	8	12	11%	7%	89	0.32
Jul-14	43,938	3,268	388,134	40,832	9	12	11%	7%	92	0.4
Aug-14	44,128	3,325	426,802	50,828	10	15	12%	8%	95	0
Sep-14	44,065	3,304	386,786	45,760	9	14	12%	7%	89	0.1
Oct-14	44,188	3,338	324,574	38,937	7	12	12%	8%	82	2.08
Nov-14	44,126	3,380	254,825	29,645	6	9	12%	8%	62	0.49
Dec-14	44,043	3,344	270,055	21,889	6	7	8%	8%	58	0.13
Jan-15	44,679	3,549	255,875	21,574	6	6	8%	8%	54	1.61
Feb-15	45,009	3,645	228,142	18,779	5	5	8%	8%	56	0.82
Mar-15	44,550	3,466	220,484	16,258	5	5	7%	8%	64	0.38
Apr-15	45,134	3,499	254,396	26,648	6	8	10%	8%	74	1.16
May-15	44,453	3,530	252,277	22,172	6	6	9%	8%	80	11.36
Jun-15	44,589	3,559	323,307	31,051	7	9	10%	8%	90	0.76
Jul-15	44,469	3,549	473,344	48,859	11	14	10%	8%	95	0
Aug-15	45,027	3,593	552,756	71,864	12	20	13%	8%	96	0
Sep-15	44,513	3,568	443,973	62,071	10	17	14%	8%	91	0.57
Oct-15	44,595	3,533	374,397	49,468	8	14	13%	8%	80	6.82
Nov-15	44,630	3,581	270,488	34,299	6	10	13%	8%	65	4.24
Dec-15	45,445	3,545	291,243	24,767	6	7	9%	8%	63	0.69

6.9 Peninsula and City-wide Pool Permits

Year	Annual Non-Peninsula Pool Permits	Annual Peninsula Pool Permits	Annual Pool Permits Citywide
1996	59	0	59
1997	108	1	109
1998	93	0	93
1999	141	0	141
2000	163	0	163
2001	128	1	129
2002	121	1	122
2003	106	9	115
2004	88	19	107
2005	109	12	121
2006	112	42	154
2007	79	39	118
2008	60	23	83
2009	31	17	48
2010	36	12	48
2011	22	19	41
2012	35	21	56
2013	23	38	61
2014	34	17	51
2015	36	26	62
Total	1584	297	1881

Year	Total Peninsula Pools Permits	Total City Pool Permits	Peninsula % of Pools in City	Peninsula % of Annual Citywide Permits Issued
1996	0	59	0%	0.0%
1997	1	168	1%	0.9%
1998	1	261	0%	0.0%
1999	1	402	0%	0.0%
2000	1	565	0%	0.0%
2001	2	694	0%	0.8%
2002	3	816	0%	0.8%
2003	12	931	1%	7.8%
2004	31	1038	3%	17.8%
2005	43	1159	4%	9.9%
2006	85	1313	6%	27.3%
2007	124	1431	9%	33.1%
2008	147	1514	10%	27.7%
2009	164	1562	10%	35.4%
2010	176	1610	11%	25.0%
2011	195	1651	12%	46.3%
2012	216	1707	13%	37.5%
2013	254	1768	14%	62.3%
2014	271	1819	15%	33.3%
2015	297	1881	16%	41.9%

6.10 Peninsula and City-wide Irrigation Permits

Year	Annual Non-Peninsula Irrigation Permits	Annual Peninsula Irrigation Permits	Annual Irrigation Permits Citywide
2000	211	0	211
2001	286	0	286
2002	320	31	351
2003	433	138	571
2004	669	131	800
2005	994	533	1527
2006	1370	569	1939
2007	673	276	949
2008	487	232	719
2009	287	146	433
2010	277	220	497
2011	235	166	401
2012	177	168	345
2013	213	228	441
2014	201	219	420
2015	133	287	420
Total	6966	3344	10310

Year	Total Peninsula Irrigation Permits	Total City Irrigation Permits	Peninsula % of Irrigation Permits in City	Peninsula % of Annual Citywide Permits Issued
2000	0	211	0%	0.0%
2001	0	497	0%	0.8%
2002	31	848	4%	0.8%
2003	169	1419	12%	7.8%
2004	300	2219	14%	17.8%
2005	833	3746	22%	9.9%
2006	1402	5685	25%	27.3%
2007	1678	6634	25%	33.1%
2008	1910	7353	26%	27.7%
2009	2056	7786	26%	35.4%
2010	2276	8283	27%	25.0%
2011	2442	8684	28%	46.3%
2012	2610	9029	29%	37.5%
2013	2838	9470	30%	62.3%
2014	3057	9890	31%	33.3%
2015	3344	10310	32%	41.9%

6.11 Customer Water Bill Statement

		Customer Water Bill Statement Agrees to Billing Register without error/difference?		
	LocID	June	July	Aug
1	95237	Yes	Yes	Yes
2	95261	Yes	Yes	Yes
3	95393	Yes	Yes	Yes
4	95405	Yes	Yes	Yes
5	95407	n/a	Yes	Yes
6	95541	Yes	Yes	Yes
7	95585	Yes	Yes	Yes
8	95751	Yes	Yes	Yes
9	98945	Yes	Yes	Yes
10	99039	Yes	Yes	Yes
11	101891	Yes	Yes	Yes
12	104069	Yes	Yes	Yes
13	104135	Yes	Yes	Yes
14	105405	Yes	Yes	Yes
15	105485	Yes	Yes	Yes
16	105699	Yes	Yes	Yes
17	107545	Yes	Yes	Yes
18	107571	Yes	Yes	Yes
19	107573	Yes	Yes	Yes
20	107615	Yes	Yes	Yes
21	107691	Yes	Yes	Yes
22	107743	Yes	Yes	Yes
23	107769	Yes	Yes	Yes
24	107893	Yes	Yes	Yes
25	109413	Yes	Yes	Yes
26	109557	Yes	Yes	Yes
27	109603	Yes	Yes	Yes
28	109669	Yes	Yes	Yes
29	110617	Yes	Yes	Yes
30	113939	Yes	Yes	Yes
31	114297	Yes	Yes	Yes
32	114361	Yes	Yes	Yes
33	116547	Yes	Yes	Yes
34	116583	Yes	Yes	Yes
35	117985	Yes	Yes	Yes
36	118007	Yes	Yes	Yes
37	119855	Yes	Yes	Yes
38	119881	Yes	Yes	Yes
39	119897	Yes	Yes	Yes
40	120225	Yes	Yes	Yes
41	121385	Yes	Yes	Yes
42	121439	Yes	Yes	Yes
43	121451	Yes	Yes	Yes
44	121771	Yes	Yes	Yes
45	122037	Yes	Yes	Yes
46	124807	Yes	Yes	Yes
47	126099	Yes	Yes	Yes
48	126115	Yes	Yes	Yes
49	126929	Yes	Yes	Yes
50	127363	n/a	n/a	n/a

*NOTE: n/a indicates there was not a utility bill to recalculate since the billing location was not setup/active during the reviewed time period

6.12 Consumption calculation test

When an exception report is generated, a current consumption amount calculates for the customer account. The previous and current readings are used to perform the calculation. In addition, the current consumption amount is compared to a calculated historical consumption amount.

Calculation percentages are setup for various consumption ranges. The percentage limits are:

- **Low limit 1**
- **High limit 1**
- **Low limit 2**
- **High limit 2**

If the current consumption amount is not within the range or limit set up, an exception message prints on the exception report. The message indicates that the consumption amount is too low or too high for either limit 1 or 2. The specific messages that are printed on the report include:

- **Consumption too low**
- **Consumption too low – limit 2**
- **Consumption too high**
- **Consumption too high – limit 2**

The consumption calculation test is performed for each customer account. The values used in the test are based on the consumption amount for each location or customer account. The steps for the consumption calculation test include:

- **Step 1 – Calculate historical daily consumption amount**
- **Step 2 – Calculate average consumption amount for the period**
- **Step 3 – Determine the consumption value limits**
- **Step 4 – Calculate the high and low consumption amounts for each limit**
- **Step 5 – Compare the current consumption amount with the high and low limits**

When limit 1 and 2 percentages are set up, Sungard Naviline automatically performs these calculations for each customer account.

Step 1

$$\frac{\text{Historical consumption amount}}{\text{Historical number of days}} = \text{Historical daily consumption amount}$$

The historical consumption amount represents the consumption used by the customer account or location during a previous period. The previous period is based on the estimating method set up in system control. The estimating method can include:

- **For the same billing period from the previous year**
- **For the same billing period from the previous year plus and minus a billing period**
- **For the previous three billing periods**
- **The average consumption to date**

The historical number of days represents the number of days in the billing periods of the estimating method. The number of days can represent one or several billing periods. The number of days is divided into the historical consumption amount to determine the historical daily consumption amount.

Example: Water service is provided to the customer. Estimated consumption is calculated based on the same billing period from the previous year. The historical consumption amount (same billing period last year) was 2,000 gallons. There were 28 days in the billing period. The historical consumption amount (2,000) is divided by the number of days (28) for a calculated daily consumption amount of 71.43 gallons.

Step 2

Historical daily consumption amount	**X**	**Current number of days**	**=**	**Average consumption amount**

The current number of days is the number of days in the current billing period. The historical daily consumption amount (step 1) is multiplied by the current number of days to estimate the average consumption for the calculation test.

Example: In step 1, the historical daily consumption amount is 71.43 gallons. There are 31 days in the current billing period. The historical consumption amount (71.43) is multiplied by the current number of days (31) to calculate the average consumption amount as 2,214.33 gallons.

Step 3

Average consumption amount	**X**	**Low range percentage**	**=**	**Low range amount**
Average consumption amount	**X**	**High range percentage**	**=**	**High range amount**

Different percentages are setup for each consumption range:

Consumption (thousands gallons)	Consumption Test Low 1	Consumption Test Low 2	Consumption Test High 1	Consumption Test High 2
0-5	100%	100%	300%	400%
5-15	100%	100%	200%	300%
15-30	90%	100%	100%	200%
30-50	90%	100%	100%	200%
50-100	80%	90%	75%	100%
100+	75%	100%	75%	100%

When limit 1 and 2 percentages are used, limit 2 calculations are performed first. If the consumption amount is outside the values calculated for limit 2, the appropriate exception message is applied. The consumption amount is not checked for limit 1 differences. If the current consumption falls within the ranges of limit 2, the calculations for limit 1 are performed.

Example: Continuing with the example, the average consumption amount is 2,214.33 gallons. For limit 1, the low range percentage amount is 350 (read as .350) and the high range percentage amount is 600 (read as .600). For limit 2, the low range percentage amount is 700 (read as .700) and the high range percentage amount is 1200 (read as 1.200).

To calculate the range amounts for limit 2, the average consumption amount (2,214.33) is multiplied by the low range percentage (.700) to calculate the low range amount as 1,550.03 gallons. The average consumption amount (2,214.33) is multiplied by the high range percentage (1.200) to calculate the high range amount as 2,657.20 gallons.

If needed to calculate the range amounts for limit 1, the average consumption amount (2,214.33) is multiplied by the low range percentage (.350) to calculate the low range amount as 775.02 gallons. The average consumption amount (2,214.33) is multiplied by the high range percentage (.600) to calculate the high range amount as 1,328.60 gallons.

Step 4

Average consumption amount - Low range amount = Low consumption test amount

Average consumption amount + High range amount = High consumption test amount

The low range amount (step 3) is subtracted from the average consumption amount (step 2) to calculate the low consumption test amount.

The high range amount (step 3) is added to the average consumption amount (step 2) to calculate the high consumption test amount.

Example: Continuing with the example, the average consumption amount is 2,214.33 gallons. For limit 2, the low range amount is 1,550.03 gallons and the high range amount is 2,657.20 gallons. For limit 1, the low range amount is 775.02 gallons and the high range amount is 1,328.60 gallons.

For limit 2 consumption test amounts, the low range amount (1,550.03) is subtracted from the average consumption (2,214.33) to calculate a low consumption test amount of 664.30 gallons. The high range amount (2,657.20) is added to the average consumption amount (2,214.33) to calculate a high consumption test amount of 4,871.53 gallons.

If needed for limit 1 consumption test amounts, the low range amount (775.02) is subtracted from the average consumption (2,214.33) to calculate a low consumption test amount of 1,439.31 gallons. The high range amount (1,328.60) is added to the average consumption amount (2,214.33) to calculate a high consumption test amount of 3,542.93 gallons.

Step 5

If current consumption amount	**<**	**Low consumption test amount – limit 2**	**=**	**Consumption too low – limit 2**
If current consumption amount	**>**	**High consumption test amount – limit 2**	**=**	**Consumption too high – limit 2**
If current consumption amount	**<**	**Low consumption test amount – limit 1**	**=**	**Consumption too low**
If current consumption amount	**>**	**High consumption test amount – limit 1**	**=**	**Consumption too high**

If the service current consumption amount is less than the limit 2 low consumption test amount, the Consumption too low – limit 2 message applies. If the service current consumption amount is greater than the high consumption test amount for limit 2, the Consumption too high – limit 2 message applies.

If the service current consumption is within the ranges of limit 2 test amounts, then the calculations are performed for limit 1. If the current consumption amount is less than the low consumption test amount for limit 1, the Consumption too low message applies. If the current consumption amount is greater than the high consumption test amount for limit 1, the Consumption too high message applies.

Example: The current consumption amount for the customer is 4,000 gallons. Since the current consumption amount falls within the limit 2 ranges, the limit 1 calculations are performed. As 4,000 is greater than the limit 1 high consumption amount (3,542.93), the exception message, Consumption too high is applied to the account.

If current consumption amount	**<**	**1,550.03**	**=**	**Consumption too low – limit 2**
If current consumption amount	**>**	**4,871.35**	**=**	**Consumption too high – limit 2**
If current consumption amount	**<**	**1,439.31**	**=**	**Consumption too low**
If current consumption amount	**>**	**3,542.93**	**=**	**Consumption too high**