2015 ANNUAL WATER LOSS REDUCTION PLAN

Implementation Status Report

BLACK & VEATCH PROJECT NO. 191656

PREPARED FOR

MIAMI-DADE COUNTY

Miami-Dade Water and Sewer Department

30 APRIL 2016

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1.0 Introduction

The South Florida Water Management District (SFWMD or District) requires the Miami-Dade Water and Sewer Department (Department) to prepare an Annual Water Loss Reduction Plan Implementation Report (Report) of its 20-year Water Loss Reduction Plan Implementation Program (Plan), per Special Permit Condtion No. 20 of the Miami-Dade County Water Use Permit (WUP) No. 13-00017-W modified on September 21, 2015. The Department retained Black & Veatch Corp. (Black & Veatch) to prepare the calendar year 2015 (2015) Report and provide assistance with the Plan implementation.

The Department's water system consists of three regional water treatment plants (Hialeah, John E. Preston and Alexander Orr), the South Dade Water System (a series of wellfields and five small treatment facilities), treated water storage and pumping facilities and approximately 7,700 to 8,000 miles of water transmission and distribution pipelines. The regional facilities have a combined rated treatment capacity of 473 MGD. The Hialeah and Preston plants serve the north part of the system, the Alex Orr plant serves the central part of the system and the South Dade Water System serves the southernmost part of the County. The South Dade Water System has a permitted capacity of 12 MGD collectively and consists of 12 wells situated in the following wellfields: Leisure City (four wells), Everglades (three wells), Elevated Tank (two wells), Newton (two wells) and Naranja (one well).

Distribution of finished water throughout the service area is accomplished with the use of seven remote finished water storage and pumping facilities as well as storage and pumping stations located at the water treatment facilities. The water system serves 477,399 active retail customers and 15 wholesale customers in a service area of approximately 435 square miles.

The overall annual average daily flow of the entire system is approximately 312 MGD. Raw water supply for the three regional treatment plants is currently drawn from 83 Biscayne aquifer wells located in the major wellfields (Miami Springs, Northwest, West, Southwest, and Snapper Creek) and several wells onsite at the three treatment plants. The South Dade Water System is served by 12 Biscayne aquifer wells located at the five smaller wellfields mentioned above.

The new Hialeah Reverse Osmosis water treatment plant is owned jointly by the City of Hialeah and the Department. The RO plant has an initial treatment capacity of 10 MGD and it is designed to have a maximum capacity of 17.5 MGD. The raw water source for this plant is the brackish Upper Floridan aquifer. The plant commenced service in November 2014.

The proposed South Miami Heights water treatment plant will replace three of the small treatment plants of the South Dade Water System. This plant will be a 20 MGD membrane softening and reverse osmosis plant and will have the capacity to treat water from both the Biscayne and Floridan aquifers. This plant is scheduled to begin service in 2018.

1.1 Background and Scope of Work

The Department's Plan was based on an evaluation of water supply and demand for fiscal year (FY) 2005. On November 15, 2007, the SFWMD approved and issued the Department its WUP No. 13-00017-W.

In December 2009, the Department submitted an application for a permit modification pertaining to the Department's alternative water supply plan. The modifications were requested as a result of lower demands and population projections. In November 2010, the SFWMD issued a revised permit expiring in 2035.

In May 2011, the Department submitted a second application for another permit modification pertaining to the Department's alternative water supply plan. The modifications were requested based on reduced water use due to slowed population growth, water loss reduction, the successful implementation of the Department's Water Conservation Plan and the adoption of a permanent county wide two day a week landscape irrigation restriction ordinance. The County's current finished water demand is approximately 32 million gallons per day (MGD) lower than what was anticipated when the first 20-year water use permit application was submitted in 2007. This demand reduction has eliminated the anticipated supply shortage which was the basis for an ambitious schedule of several costly near-term alternative water supply projects.

On July 16, 2012, the SFWMD issued a revised permit which expires on December 16, 2030 and another revised permit expiring February 9, 2035. The permit was modified again on September 21, 2015. A copy of the Water Use Letter Modification is included in Appendix I.

The Plan includes real and apparent water loss mitigation approaches over the next 20 years with corresponding monetary savings and implementation schedule recommendations. The schedules of the real and apparent water loss reduction activities are presented in Appendix A as Exhibits 17A and 17B of the revised WUP. The tables also provide the anticipated annual water savings and related annual value of water savings for the water loss reduction activities. Special Permit Condition No. 20 of the revised WUP specifically applies to implementation of the approved Water Loss Reduction Plan. Key requirements of the Condition are as follows:

- Quarterly determination of distribution system losses
- Annual reporting of distribution system losses on April 30 of each year for the previous calendar year
- Determination of losses in each water treatment plant (WTP)
- Water audits in accordance with IWA/AWWA standard methodologies
- Planned annual reporting of water loss reduction activities and expenditures, along with associated water savings for the subsequent calendar year
- Annual reporting of water loss reduction trends and changes from the previous year

2.0 2015 Water Audit and Water Loss Overview

Reducing real and apparent losses is important to the Department. Specifically this includes leakage of mains and service lines, the accuracy of meters and the interactions of the customer billing system. The Department is continuously implementing improvements to enhance revenue and increase efficiency. As an example in 2015, there were 3,041 water leaks reported with 1,491 leaks the result of the pro-active leak detection program. This is an increase of 250 leaks above what was reported in 2014 (1,241 leaks).

2.1 Water Loss Control Improvements in the Audit Year

2.1.1 Validation of Results

The Department has increased and improved its efforts over the past calendar year to understand and audit all variables within the AWWA standard water audit. In order to make informed decisions, increased meter testing (including change-outs and repairs of several large meters) has improved the validation grade. As a result, the estimated validation utilizing the AWWA grading had increased from 75 (out of 100) in 2014 to 77 in 2015 because of a better understanding of the Department's water system. The increase in validation was because of the focus on water exported and billed metered components. For water exported, the meters were evaluated, repaired or changed out during 2015; AMR was installed on all export and large customer meters and testing increased for both export and retail customer components. In addition, the Department conducted AMR/AMI feasibility studies in 2014 and 2015.

2.1.2 Leakage Reduction

With the Department's continued focus on leakage reduction, the entire distribution system is surveyed on an annual basis. The system-wide survey takes approximately 10 months to complete plus an additional 2 months for equipment maintenance. The program has an effective in-house equipment maintenance program that prevents downtime common with other programs. Department staff estimates that they have saved approximately $1 million over the past 5 years due to the crew's ability to repair and maintain the leak detection equipment. The program is relatively unique in that they complete 100% of surveying with leak sound loggers utilizing a "lift and shift" technique. In addition, the Department completed a pilot program in 2014 that evaluated the effectiveness of fixed network leak logger systems. Due to the success of the program, the Department now has two areas where permanently installed loggers are monitored on a fixed network. The areas selected for permanent installation are downtown since conducting standard survey techniques in these areas are dangerous due to heavy traffic. The fixed network enables the program to complete a survey of the selected areas on a daily basis if needed.

The increase of 250 detected leaks above the previous year's total of 1,240 is due to reducing the distance between loggers in selected areas. To determine the spacing, the leak detection crew tested the loggers against a point to point survey with an Aquascope. The pilot revealed that by reducing the logger spacing from 1000' to 100' in selected areas, the Department was able to gain thorough coverage. While this method will not identify all meter coupling leaks (especially on poly service lines), it has increased the number of leaks detected. While this has proved successful detecting more of the small, drip dry leaks at meters it may not be economically feasible.

The leak detection field staff consists of a total of seven personnel: four survey technicians, four pinpointing technicians, one person that analyzes all leak logger sound, one person that selects the logger locations and one person who manages the data. There are also managerial and administrative personnel who are involved in the operation, but are not included in these numbers.

The Department is now evaluating the effectiveness of a mobile SMS network as another way to survey with loggers (See Appendix I for leak program details and recommendations). This is similar to the fixed network, but has more mobility as it is connected to a wireless network rather than a specific dedicated collector. This method does not require line of site to gather reads.

2.1.3 District Metering

District metering refers to recording all flows into a discrete area of the distribution system. Data regarding inflows into the discrete area provide the basis of assessing levels of water loss, as well as aiding in quantifying actual reductions in the levels of water losses achieved by various activities. Real loss is usually assessed based on the minimum flow rate in a given area. The Minimum Night Flow usually occurs between 2:00 AM and 4:00 AM each morning, and is one of the most meaningful pieces of data for measuring leakage. However, in the Department-case, there will be sectors within the distribution system where the minimum flow rate does not occur during this period. For example, those areas with newer homes which have automatic sprinkler systems can change the water use characteristics considerably. Automatic sprinklers are often set between 2:00 AM and 4:00 AM. In these cases, it is more difficult to determine the minimum flow unless artificial methods are incorporated such as restricting outdoor water use to specific days of the week. During the lowest-use period, the pressure is higher, authorized consumption is at a minimum, and therefore, leakage is at its maximum percentage of the total flow. If there are days of the week where no irrigation is allowed, then it's possible to continue with this practice during the rest of the year.

2.1.4 Meter Testing and Replacement

The meter testing program continued in 2015 which includes analysis of both residential and commercial meters. It is the goal of the Department to test all 3" and larger meters on an annual basis. In general, wholesale meters 3" and larger are tested twice per year. High use meters are tested multiple times per year if cost justified. Problematic meters are being defined and repaired or replaced. This, combined with the continuing production meter testing allows the Department to more accurately allocate the losses shown on the audit. The apparent loss per service connection per day reduced from 22.01 gpd in 2014 to 20.47 gpd in 2015.

2.2 Estimated Water Savings

The WUP requires continually improving water loss control over the life of the permit. The 2015 audit analysis shows that apparent losses have reduced slightly. The data continues to improve, but the level of savings still needs to be trended over time to prove they are consistent and increasing the system's efficiency. As understanding of real and apparent losses improve, these audit values will continue to change and the recommendations for reduction in water loss and the associated water savings will become more evident.

2.3 AWWA Water Balance Analysis Overview

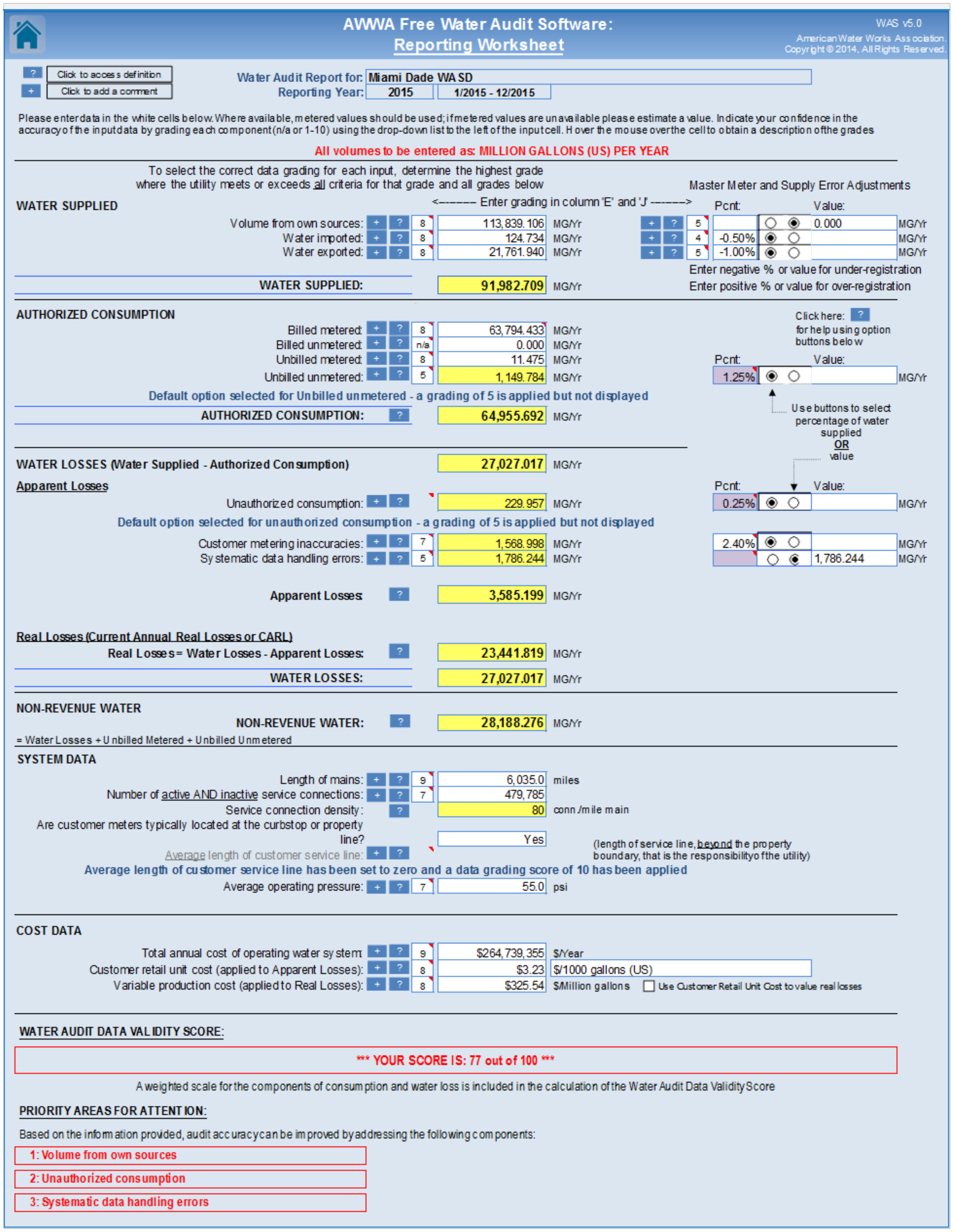
The water balance was developed using the AWWA Water Audit Software and analysis of existing data provided by the Department. The comparison of data from 2011 through 2015 is shown in Table 2-1. It should be noted that there are areas where data validation needs to be improved to verify the input values and performance indicators (PIs).

Table 2-1 Standard AWWA Water Balance Analysis

PERFORMANCE INDICATOR (PI)	UNITS	2011	2012	2013	2014	2015

Total NRW (% by volume)	%	30.2%	27.9%	26.7%	29.1%	30.6%
Apparent Loss	Gallons/conn/day	44	22	22	22	20
Real Loss	Gallons/conn/day	126	120	113	127	134
AWWA grading	(1-100)	73	78	77	75	77

Figure 2-1 shows a screenshot of the completed AWWA Free Water Audit Software© for 2015. All data for Figure 2-1 were developed from the information provided by the Department including flow and billing records analyzed for 2015. The detailed reporting worksheets (including key PIs comparisons) for the audit are found in Appendix B.



AWWA Free Water Audit Software:
Reporting Worksheet

WAS v5.0
American Water Works Association.
Copyright © 2014, All Rights Reserved.

Water Audit Report for: Miami Dade WASD
Reporting Year: 2015 1/2015 - 12/2015

Please enter data in the white cells below. Where available, metered values should be used; if metered values are unavailable please estimate a value. Indicate your confidence in the accuracy of the input data by grading each component (n/a or 1-10) using the drop-down list to the left of the input cell. Hover the mouse over the cell to obtain a description of the grades

All volumes to be entered as: MILLION GALLONS (US) PER YEAR

To select the correct data grading for each input, determine the highest grade where the utility meets or exceeds all criteria for that grade and all grades below

<------ Enter grading in column 'E' and 'J' ------>

Master Meter and Supply Error Adjustments

WATER SUPPLIED

	Grade	Value		Grade	Pcnt:		Value:	
Volume from own sources:	8	113,839.106	MG/Yr	5		○ ●	0.000	MG/Yr
Water imported:	8	124.734	MG/Yr	4	-0.50%	● ○		MG/Yr
Water exported:	8	21,761.940	MG/Yr	5	-1.00%	● ○		MG/Yr

Enter negative % or value for under-registration
Enter positive % or value for over-registration

WATER SUPPLIED: 91,982.709 MG/Yr

AUTHORIZED CONSUMPTION

Click here: ? for help using option buttons below

	Grade	Value		Pcnt:		Value:	
Billed metered:	8	63,794.433	MG/Yr				
Billed unmetered:	n/a	0.000	MG/Yr				
Unbilled metered:	8	11.475	MG/Yr				
Unbilled unmetered:	5	1,149.784	MG/Yr	1.25%	● ○		MG/Yr

Default option selected for Unbilled unmetered - a grading of 5 is applied but not displayed

AUTHORIZED CONSUMPTION: 64,955.692 MG/Yr

Use buttons to select percentage of water supplied
OR
value

WATER LOSSES (Water Supplied - Authorized Consumption) 27,027.017 MG/Yr

Apparent Losses

	Grade	Value		Pcnt:		Value:	
Unauthorized consumption:		229.957	MG/Yr	0.25%	● ○		MG/Yr
Customer metering inaccuracies:	7	1,568.998	MG/Yr	2.40%	● ○		MG/Yr
Systematic data handling errors:	5	1,786.244	MG/Yr		○ ●	1,786.244	MG/Yr

Default option selected for unauthorized consumption - a grading of 5 is applied but not displayed

Apparent Losses: 3,585.199 MG/Yr

Real Losses (Current Annual Real Losses or CARL)

Real Losses = Water Losses - Apparent Losses: 23,441.819 MG/Yr

WATER LOSSES: 27,027.017 MG/Yr

NON-REVENUE WATER

NON-REVENUE WATER: 28,188.276 MG/Yr

= Water Losses + Unbilled Metered + Unbilled Unmetered

SYSTEM DATA

	Grade	Value	
Length of mains:	9	6,035.0	miles
Number of active AND inactive service connections:	7	479,785	
Service connection density:		80	conn./mile main
Are customer meters typically located at the curbstop or property line?		Yes	
Average length of customer service line:			(length of service line, beyond the property boundary, that is the responsibility of the utility)
Average operating pressure:	7	55.0	psi

Average length of customer service line has been set to zero and a data grading score of 10 has been applied

COST DATA

	Grade	Value	
Total annual cost of operating water system:	9	$264,739,355	$/Year
Customer retail unit cost (applied to Apparent Losses):	8	$3.23	$/1000 gallons (US)
Variable production cost (applied to Real Losses):	8	$325.54	$/Million gallons ☐ Use Customer Retail Unit Cost to value real losses

WATER AUDIT DATA VALIDITY SCORE:

*** YOUR SCORE IS: 77 out of 100 ***

A weighted scale for the components of consumption and water loss is included in the calculation of the Water Audit Data Validity Score

PRIORITY AREAS FOR ATTENTION:

Based on the information provided, audit accuracy can be improved by addressing the following components:

1: Volume from own sources
2: Unauthorized consumption
3: Systematic data handling errors

Figure 2-1 Water Audit software for 2015

Analysis of this report is structured in the format of the standard water balance focusing on the following sections: water supplied, authorized consumption, water losses, system data and cost data.

The AWWA Free Water Audit Software© (version 5.0) has been used to calculate all the required indicators which is then used to develop an overall water balance and relevant PIs. Each variable has been discussed with relevant staff or through analysis of data and the reason for each value recorded. All values noted in this section have been developed from data provided by the Department and represents 2015.

In overview, the data provided by the Department appears to be of good quality and validation.

The reported performance of apparent losses of approximately 20 gallons per connection per day, the real loss performance of approximately 134 gallons per connection per day, and Infrastructure Leakage Index of 11.16 are relatively high, but still within the range of PIs for utilities of similar size and age within North America.

It should be noted that the level of real water loss increased from 2014 to 2015. The level of apparent loss decreased but overall water loss increased from 24,971.465 million gallons (MG) in 2014 to 27,027.017 MG in2015.

2.4 Water Loss Standards and Reduction Strategies

This section presents current international water loss reduction strategies and highlights the advantages, disadvantages and their applicability to the Department's system. In this section the following will be covered:

- Identify current water loss reduction strategies
- Critique and highlight advantages and disadvantages of identified strategies
- Compare strategy implementation to current Department policy
- Research strategy and implementation.

Water loss reduction strategies are best built upon calibrated and standardized models. There are two kinds of audits that can be performed: a top-down water audit, and a bottom-up water audit. The following section is split into two parts. The first part, the top-down water audit, discusses the modeling/audit tools and methods that are used to properly quantify losses and design the strategy. The second part, the bottom-up water audit, discusses intervention tools commonly used to reduce losses.

2.4.1 Top-Down Water Audit Data Validation & Confidence Limits

The first step of the Top-Down Water Audit is to identify a group of stakeholders within the utility to aid with gathering the required data for a first look at the utility performance. Data is gathered and entered initially into a simple water balance model. The water balance model provides the level of detail for which data is currently available at this desktop analysis level. Figure 2-2 shows the major components of the most current AWWA/IWA standard water balance model.

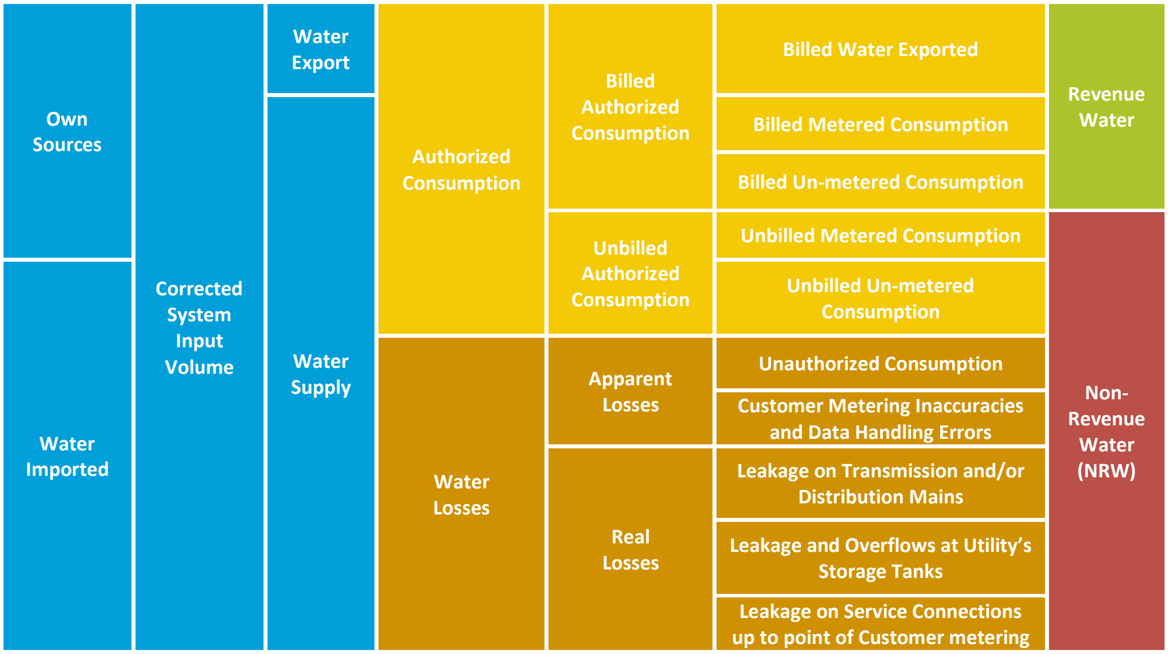


Figure 2-2 The Standard IWA Water Balance

Once data is gathered and the utility starts entering it in the water balance model, it is likely that some components of the required data are either not available or were originally derived from estimates or engineering judgments. During the top-down auditing process, these components are assigned a relatively low data confidence level through a standardized grading system developed by AWWA in the AWWA Free Water Audit Software©.

Even with basic data, most utilities find that they are able to prepare an initial water balance. Confidence or grading levels for each input component is recorded, and the model provides an aggregated confidence level for the main water loss component categories.

Once an aggregate confidence level is obtained, the utility can identify the components that will have the largest impact on improving the aggregated confidence of either the apparent loss volume or the real loss volume. These input components are then typically prioritized for field validation as discussed below.

2.4.2 Data Validation & Confidence Limits

The key to building a business case for intervention against water loss is to base it on facts. Building a business case on anecdotal or estimated data can result in costly investments that do not provide the expected return. Field-validating data can be expensive, but the alternative may be more expensive if the wrong decisions are made.

Without field validation of data, an interim measure includes the analysis using the grading scale associated with the AWWA water audit software (AWWA - Version 5.0, 2014). This measurement is not as valid as a field-study audit. However, it gives an indication of the accuracy of results, and where data collection and water loss investment should be targeted.

As previously mentioned, the Department has an estimated data confidence grade of 77 for 2015. This grade is developed through estimation of the data validity of each input value. As the validation of data improves, this grade will also improve. The current grade suggests that the data still need improvement but that some high-level decisions on targeting of resources can be made to increase the level of service, reduce losses and enhance revenue.

One typical place to begin field validation is usually with assessing the accuracy of the supply meters and an update to the volume entered in the model for the audit period. After investigation of the supply meters, the next step is assessing the accuracy of various categories of consumer meters. The Department has conducted calibration testing of all supply meters from the treatment plants in 2012, 2013, 2014 and 2015. Consumer meter accuracy validation is usually done on statistically representative batches of meters. A final step in this process is to validate the various consumption volumes.

2.4.3 Performance Indicators

Another component of the water balance model in addition to confidence levels is the existence of PIs. The new standard audit provides PIs for all of the water loss components, as well as for some of the basic financial indicators (Table 2-2). As the audit is refined over time, additional PIs can be incorporated to expand the scope and depth of the analysis. The use of PIs, as opposed to using a percentage loss based on the total water supplied, allows the utility to accurately produce baseline data, track performance, compare to similar size utilities and set targets with priority on the components of water loss that will reap the most cost effective returns.

Table 2-2 Details of Selected Key PIs

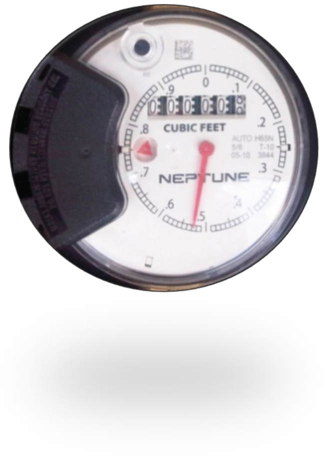
COMPONENT	TYPE	BASIC PI	DETAILED PI
Non-Revenue Water (NRW)	Financial	Volume of NRW as % of System Input Volume	Value of NRW as % of cost of running system. $ For apparent and real losses.
Real Losses (RL)	Water Resources	Volume of RL as % of System Input Volume	
Real Losses	System Operational	Gallons/service connection/day	Infrastructure Leakage Index (ILI)
		Gallons per mile of main per day (not used for MDWASD as not relevant for urban utility)	Defined as the ratio of the current annual real loss to the unavoidable annual real loss = CARL/UARL
Apparent Losses (AL)	Operational	Volume of AL as % of System Input Volume	Gallons/service connection/year
Water Losses (WL)	Operational	Gallons/service connection/year	

Tracking several standard PIs allows utilities to easily see the longer-term performance of water loss management programs as a unique entity. Shorter payback initiatives can quickly be identified ensuring a rapid return on investment.

Within the financial, operational, and water resources categories, PIs have been recommended for both basic and detailed levels. Intermediate PIs have also been proposed in some cases; however, this report will concentrate on only a few of the key and most useful PIs relating to water losses and non-revenue water.

Key PIs recommended for use in the Department's water loss management study are:

- Apparent Losses (Gallons/service connection/day, and lost revenue)
- Real Losses (Gallons/service connection/day, and lost revenue)
- Infrastructure Leakage Index (ILI - dimensionless)



Apparent and real loss PIs can be used to establish baseline information and track performance of an individual utility's loss management efforts. The volumes can be directly translated into dollar values for simple or more complex economic calculations as the scope of this or subsequent analysis evolves. The percentage terms are not recommended as they are subject to wider variations, and conflict with previously reported data due to differing methodologies in the analysis.

To better understand and begin calculating PIs, below are definitions and key related terms for this stage of the Department's audit:

- *Apparent Losses* – Apparent losses consist of unauthorized consumption and volumes of water lost through meter under-registration and data handling errors. The key impact of reducing apparent losses is an improved revenue stream, and a more equitable distribution of cost to the customer
- *Real losses* – Real losses consist of water leaks and breaks (either reported or unreported), background leakage that is attributed to infrastructure conditions, and reservoir or storage overflows or leakage. The key impact of reducing real losses is a direct reduction in water use
- *Infrastructure Leakage Index* – A dimensionless ratio of the Current Annual Real Losses (CARL) to the Unavoidable Annual Real Losses (UARL)
- *Unavoidable Annual Real Loss* – The theoretical lowest level of annual real losses achievable when the system is pressurized. The UARL calculation takes into account length of the water mains, number of service connections, average length of service connections (curb stop to meter or first point of usage), and operating pressure.

Once volumes of apparent and real losses have been identified and validated using the water balance tools, the dollar values of these components can be clearly defined. The value of the loss along with the cost of intervention can be assessed and a business case can be made for reduction of volume of losses to economic levels.

There are additional targeted PIs which can be used by the Department to analyze specific areas of the utility's business. These PIs include the number of zero readings, stopped meters and testing of inaccurate meters. These indicators can be recorded and trended over time to improve system knowledge, efficiency, and accountability.

3.0 Data Analysis

The AWWA Free Water Audit Software© (version 5.0) has been used to calculate all the required indicators. This is then used to develop an overall water balance and relevant PIs for the utility. The details of this methodology are found in AWWA Manual M36 (Water Audits and Loss Control Programs, 3rd Edition, 2009) and within the AWWA Free Water Audit Software. Sections in this document are structured to follow the format of the standard water balance as described in the previous section. The following categories are the focus for analysis:

- **Water supplied** (all the water input into the system, including imports and removing exported or wholesale water)
- **Authorized consumption** (metered and billed usage and other authorized uses)
- **Water losses** (meter inaccuracies, billing errors, theft and leakage)
- **System data** (miles of main, pressure, number of connections)
- **Cost data** (total cost of operating the water system, retail unit and variable production costs)

Each variable has been discussed and the reasoning behind each value recorded. All values noted in this section have been developed from data provided by the utility and are for 2015.

This data which is used to determine the following inputs should be validated by Department staff on a regular basis to ensure inputs are as accurate as possible. Additionally, it's recommended to conduct an audit on an annual basis to determine performance trends and any data errors. There are a number of variables that are currently estimated (including meter accuracy, and unbilled unmetered water) as defined in the following subsections. For a more accurate analysis these data points should be measured in the system for future audits.

3.1 Water Supplied

Total Water Supplied = 91,982.709 Million Gallons (MG)

[Calculation: Volume from Own Source + Imported water – Exported (wholesale) water]

3.1.1 Volume from Own Sources

This includes all the volume from the water treatment plants (see Table 3-1).

The Department provided production details via documents titled "Wtr-WP5a Water Produced and Purchased", and "Wtr-WP5". The production was then cross-checked against the document "Total Water Production 2015.pdf". There is one anomaly identified during the production analysis. It seems unlikely that the volume documented for the Hialeah RO plant is exact from July through October as the same value input (116,219 MG).

The total produced volume for 2015 was recorded as 113,839.106 MG. This was a slight increase (3.475 MG) from the 110,364.440 MG produced in 2014. It's possible the increase is due to the Hialeah RO plant coming on-line in November of 2014 and producing water for all 12 months of 2015.

Table 3-1 2015 Water Produced (X 1000 Gallons)

MONTH	HIALEAH	PRESTON	ORR	REX	RO HIALEAH	TOTAL
JAN	1,712,100	2,371,500	5,097,000	220,300	74,121	9,475,021
FEB	1,580,000	2,161,500	4,524,000	206,500	105,060	8,577,060
MAR	1,714,700	2,481,800	5,329,000	230,400	101,003	9,856,903
APR	1,612,400	2,521,700	5,248,000	218,500	19,412	9,620,012
MAY	1,491,600	2,466,600	5,410,000	222,100	26,016	9,616,316
JUN	1,565,100	2,186,000	5,362,000	214,000	112,500	9,439,600
JUL	1,748,500	2,073,900	5,579,000	221,500	**116,219**	9,739,119
AUG	1,630,890	2,116,250	5,449,000	222,759	**116,219**	9,535,118
SEP	1,625,666	2,031,030	5,198,000	203,549	**116,219**	9,174,464
OCT	1,698,100	2,241,430	5,388,000	213,200	**116,219**	9,656,949
NOV	1,657,210	2,043,650	5,307,000	203,931	103,900	9,315,691
DEC	1,643,000	2,159,800	5,697,000	216,400	116,653	9,832,853
Totals	**19,679,266**	**26,855,160**	**63,588,000**	**2,593,139**	**1,123,541**	**113,839,106**

3.1.2 Master Meter Error Adjustment

Analysis of the Alexander Orr Jr., Hialeah and John E Preston water treatment plants Venturi meters (Raw) were analyzed as within allowable limits of accuracy (av ~101%) and the finished water meters were analyzed as within allowable limits of accuracy (av ~99.5%). Since all the values reviewed are within the calibration limits the assumption is that the meters are accurate and so there is no master meter error adjustment recorded.

The total master meter error adjustment assigned for 2015 was recorded as 0 MG.

3.1.3 Imported Water

In 2015, the Department imported water from two suppliers – the City of Homestead and the City of North Miami Beach (Table 3-2). These entities provide water to locations within the Department's system that are difficult to reach with the current pumping system.

Table 3-2 2015 Water Purchased (X 1000 Gallons)

MONTH	HOMESTEAD	NORTH MIAM BEACH	TOTAL
January	410	12,474	12,884
February	3,032	5,188	8,220
March	2,460	6,305	8,765
April	2,840	7,750	10,590
May	3,030	**8,201 (estimate)**	**11,231**
June	**10**	8,387	8,397
July	1,183	11,414	12,597
August	3,632	10,894	14,526
September	1,037	4,697	5,734
October	4,922	4,290	9,212
November	6,472	5,335	11,807
December	5,873	4,898	10,771
Total	***34,901***	***89,833***	***124,734***

The value for imported water during 2015 was recorded as 124.734 MG. This value included 34.901 MG from Homestead and 89.833 MG imported from North Miami Beach. This represents a decrease of 27.53 MG compared to the 2014 value of 152.264 MG. Source reports were not available from North Miami Beach for the month of May. The value input was a result of averaging the previous three years purchase amount.

3.1.4 Exported Water

The Department sells water to 15 wholesale customers through 81 wholesale meters. Quantities were summarized from metered sales data (invoices) for 2015. A list of wholesale customers and quantities sold is provided in Table 3-3 for 2014 and 2015. Total water sold in 2015 was recorded at 21,761.940 MG.

A master meter error adjustment for exported water was estimated at 1% with a validation grade of 6 for 2015. The 1% value was estimated due to a number of meters expected to be at the edges of the standard accuracy limits because of age. The Department implemented a large customer meter assessment program in 2015 that targeted meter profiles and accuracy which will increase the validation score and provide more data for accuracy calculations in 2016. It is the Departments objective to test export meters twice per year and actively repair or replace all problematic meters. To increase accuracy, the Department needs to test all export by-pass meters as several of these meters register very little to no consumption.

The Department employs three full-time large water (commercial and wholesale) meter testing personnel. The duties of these personnel include water meter testing, repairs, installations, customer shut-offs and inspections. Each meter technician is responsible for completing all necessary meter tests in their given territory. It is the goal of the Department to test wholesale meters twice per year and most commercial or large customer meters (3"+) annually. The protocol employed by the Department insures that experienced technicians are testing all large meters where possible. The number of large meters tested increased during the second half of 2015. This led to more large meter tests being conducted in 2015 than in 2014 and was directly related to a study that was commissioned to help with the reduction of non-revenue water. Large under-registering meters identified during the large meter evaluation were repaired or replaced immediately.

Table 3-3 2014/2015 Miami Dade Water and Sewer Department Wholesale Sales – Thousand Gallons

WHOLESALE CUSTOMERS	2014	2015
Miami Beach	7,581,004	8,451,039
Hialeah	7,105,359	6,713,718
North Miami	1,823,132	1,836,723
Opa-Locka	916,486	960,675
Hialeah Gardens	591,156	742,288
Medley	481,176	357,569
North Bay Village	408,685	428,449
Bal Harbour	398,741	514,266
Surfside	314,790	322,934
Bay Harbor Islands	305,653	319,073
West Miami	270,650	254,527
Homestead	216,829	649,068
Indian Creek Village	118,073	126,456
Virginia Gardens	87,931	82,074
North Miami Beach	806	3,080
Wholesale Water Sold	**20,620,469**	**21,761,940**
Retail	63,470.026	63,794,433
Total Water Sold	**84,090,495**	**85,556,373**

Several wholesale meters were out of service at various times throughout the year. When meters are out of service, billing was estimated based on the previous year's consumption. During the second half of 2015, Department personnel conducted meter change-outs and repairs that will positively impact the apparent loss for the 2016 audit.

3.1.5 Other Water Supplied Notes

There are no other water supplies other than ASR wells (which are used for testing) and the Hialeah RO plant. The ASR wells are not currently connected to the supply system. The Hialeah RO plant was operational in 2015. Table 3-4 shows the 2015 validation grading for water supplied.

Table 3-4 Water Supplied Validation Grading

GRADED VARIABLE	GRADING	REASONING
Volume from Own Sources	8	Calibration conducted annually, occasional flow testing
Master Meter Error	5	Meter calibrations conducted, continuously evaluated
Water imported	8	Calibrations conducted annually by wholesale entities. Results not known.
Water Exported	8	Meters tested bi-annually. Not all configurations allow for flow testing

3.2 Authorized Consumption

Total Authorized Consumption = 64,611.518 MG

[Calculation: Authorized Consumption =Billed metered + Billed unmetered + Unbilled metered + Unbilled unmetered]

Authorized consumption includes the volume of water sold to registered customers and others entities that have been authorized and tracked by the Department. It should be noted that this does not include water exported. Authorized consumption may include items such as fire-fighting and training, flushing of sewers, transmission and distribution mains, street cleaning, watering of Department facilities, etc.

3.2.1 Billed Metered Consumption

The billed metered consumption includes almost all customers within the Department's jurisdiction. This will include all residential, commercial, industrial and institutional customers. Since the system is reportedly 100% metered, all but a very small portion should fall into this category. Note that the wholesale volume has been removed from this billed metered value (each wholesale customer has its own regulatory reporting requirements and own water losses: these volumes are removed from the audit at the water supplied stage of accounting). Department personnel have conducted extensive retail meter testing over the past year to evaluate the level of losses with respect to meter accuracy.

The value of Billed Metered Consumption for 2015 was recorded as 63,794,433 MG.

3.2.2 Billed Unmetered Consumption

There is reportedly no billed unmetered consumption. The value for Billed Unmetered Consumption in 2015 was recorded as 0 MG.

3.2.3 Unbilled Metered Consumption

There is usually only a small amount of water in this category. It can include Department facilities that have a meter but do not receive a bill, i.e. parks, fountains etc. In 2014, the value for Unbilled Metered Consumption was recorded as 21.705 MG. Information provided included metered reads from cleaning gravity/sewer mains (498,000 gallons) and Department installations (10,595,000 gallons). The total of 11.475 MG calculated for the 2015 audit value represents a decrease of 10.23 MG compared to 2014.

3.2.4 Unbilled Unmetered Consumption

Unbilled unmetered consumption is often difficult to calculate, although almost every utility has consumption in this category (due to the way systems are flushed, and fire-fighting occurs, which make it almost impossible to measure by metering effectively). The leak detection program personnel provided the NRW quarterly reports that documented the estimated flushing values as well as the estimated leakage water recovery (see in Real Loss section of this report). This information was obtained during the site visit on March 30th, 2016. The value for 2015 was estimated at 232 MG (Table 3-5). The amount attributed to flushing estimates for inspection, distribution, automatic devices, as well as estimates from the hydrant section and Vactor truck usage. It also included estimates from the Fire Departments at Coral Gable, city of Miami and Miami Dade County. The overall estimate appears to be somewhat low which is common for utilities of this size. Therefore, a default has been developed within the water audit software to allow an approximate calculation using validated data from other systems. The 2015 audit default of 1.25% of water supplied has been chosen for this input and recorded as 1,149.784 MG.

Table 3-5 and 3-12 were generated from the internal quarterly non-revenue water (NRW) report obtained from the leak detection team during the site visit. This report accounts for all 4 quarters of 2015 and combines the "Flushed Water Accounted" estimates with the "Leakage Water Recovery" estimates.

Table 3-5 Flushing Water Estimates for 2015

FLUSHING WATER ACCOUNTED – ESTIMATED FOR QUARTERLY INTERNAL NRW REPORT							
Month/Qtr	**Inspection**	**Distribution**	**Automatic Devices**	**Fire Department-Coral Gable/City of Miami/Miami Dade County**	**Hydrant Section**	**Vactor Trucks Usage**	**Total**
Jan	2,831,311	10,409,565	2,111,400	1,198,287	155,641	202	16,706,406
Feb	4,080,541	7,834,731	1,958,400	1,271,791	142,811	0	15,288,274
Mar	169,130	17,673,430	2,142,000	1,312,816	191,685	0	21,489,061
Qtr 1	**7,080,982**	**35,917,726**	**6,211,800**	**3,782,894**	**490,137**	**202**	**53,483,741**
Apr	344,172	11,747,486	2,050,200	1,285,466	125,238	0	15,552,562
May	5,315,237	7,625,382	2,111,140	440,597	197,880	0	15,690,236
Jun	5,327,896	6,859,175	2,111,400	0	145,070	0	14,443,541
Qtr 2	**10,987,305**	**26,232,043**	**6,272,740**	**1,726,063**	**468,188**	**0**	**45,686,339**
Jul	3,529,352	11,185,662	2,264,400	15,833	0	0	16,995,247
Aug	5,073,431	7,071,124	2,111,400	15,833	0	0	14,271,788
Sep	4,208,311	10,773,404	2,111,400	15,833	0	0	17,108,948
Qtr 3	12,811,094	29,030,190	6,487,200	47,499	0	0	48,375,983

Oct	3,990,727	6,589,129	2,111,400	15,833	159,695	n/a	12,866,784
Nov	4,996,107	54,537,397	2,142,000	15,833	126,238	n/a	61,817,575
Dec	1,952,785	5,511,210	2,142,000	15,833	217,632	n/a	9,839,460
Qtr 4	10,939,619	66,637,736	6,395,400	47,499	503,565	n/a	84,523,819
Total	**41,819,000**	**157,817,695**	**25,367,140**	**5,603,955**	**1,461,890**	**202**	**232,069,882**
Monthly AVG	**3,484,917**	**13,151,475**	**2,113,928**	**466,996**	**121,824**	**n/a**	**19,339,157**

3.2.5 Other Authorized Consumption Notes

As part of ongoing operations, it is necessary for water treatment plants to use water for back-flushing and other functions. However, it's probable that water use occurs prior to the finished water meter. Therefore this data is not included in this water audit. Table 3-6 shows the 2015 validation grading for authorized consumption.

Table 3-6 Authorized Consumption Validation Grading

GRADED VARIABLE	GRADING	REASONING
Billed Metered	8	Good billing systems, extensive meter accuracy testing increased in 2015. Regular replacement of oldest meters
Billed Unmetered	n/a	No billed unmetered consumption reported
Unbilled Metered	8	Unbilled meter are read and maintained in the same manner as retail meters. Still need to evaluate testing and billing procedures for unbilled properties
Unbilled Unmetered	5	The default was used for this variable

3.3 Water Losses

Total Water Losses = Total Water Supplied – Total Authorized Consumption

Total Water Losses = 27,027.017 MG

The Department completes quarterly internal non-revenue water loss reports. The 2014/2015 reported quarterly values are documented in Table 3-7. Values input were derived directly from the data request forms which are from the internal non-revenue report obtained from the leak detection program personnel during the site visit. The total includes flushing and leak recovery estimates.

Table 3-7 Quarterly internal non-revenue water loss report values

QUARTER	FY 2014	FY 2015
1st Quarter	3,322,980,054	3,623,975,593

2nd Quarter	2,859,769,742	3,022,506,607
3rd Quarter	3,308,826,838	3,413,153,030
4th Quarter	2,519,987,788	2,608,312,677
Estimated Total	**12,011,564,422**	**12,667,947,907**

The water losses are further broken down into apparent losses and real losses, which are both outlined below.

3.4 Apparent Water Losses

Total Apparent Water Losses = 2,579.690 MG

[Calculation: Apparent Water Losses =Unauthorized consumption + Customer metering inaccuracies + Systematic data handling errors]

3.4.1 Unauthorized Consumption

Unauthorized consumption includes all uses not authorized by the Department, including illegal use of hydrants, bypasses etc., as well as reversed or tampered meters and AMR systems. In this audit the data was not available; therefore, the default of 0.25% of water supplied was used. The value for 2015 was recorded as 229.957 MG. This represents an increase of 6 MG over the 2014 value.

3.4.2 Customer Meter Inaccuracies

It is the objective of the Departments meter testing program to test all meters 3” and larger on an annual basis. A testing program for the smaller meters is also operational. It is expected that the current meter stock is relatively accurate; however, additional testing on the 1” to 2” meters may be necessary to verify the accuracy. Testing should analyze meter age, throughput (volume through the meter) and if possible average pressure at the meter location.

The Department took steps to better understand customer meter inaccuracies during 2015 by implementing a large customer meter assessment project testing 1,241- 5/8” meters. As was the case in 2014, the estimate of 2.4% was used to calculate underreporting across the meter stock in 2015 (1,568.998 MG). The Department quickly repaired or replaced several underperforming meters during 2015. The validation grade and data accuracy will likely increase for the 2016 audit as the Department continues to increase the number of meters tested, repaired and replaced. Currently, very limited testing is being completed on 1”, 1.5”, and 2” meters.

Out of the 1,241 - 5/8” meters that the Department tested during 2015, 828 meters failed at least one of the 3 tests completed (Low, Mid, High). Because of the high number of failed low flow tests (over-registering), it is recommended that the meter test facility is audited to ensure accuracy. Figure 3-1 shows the results of the low flow tests conducted. To view the data of all meter tests, see Appendix G.

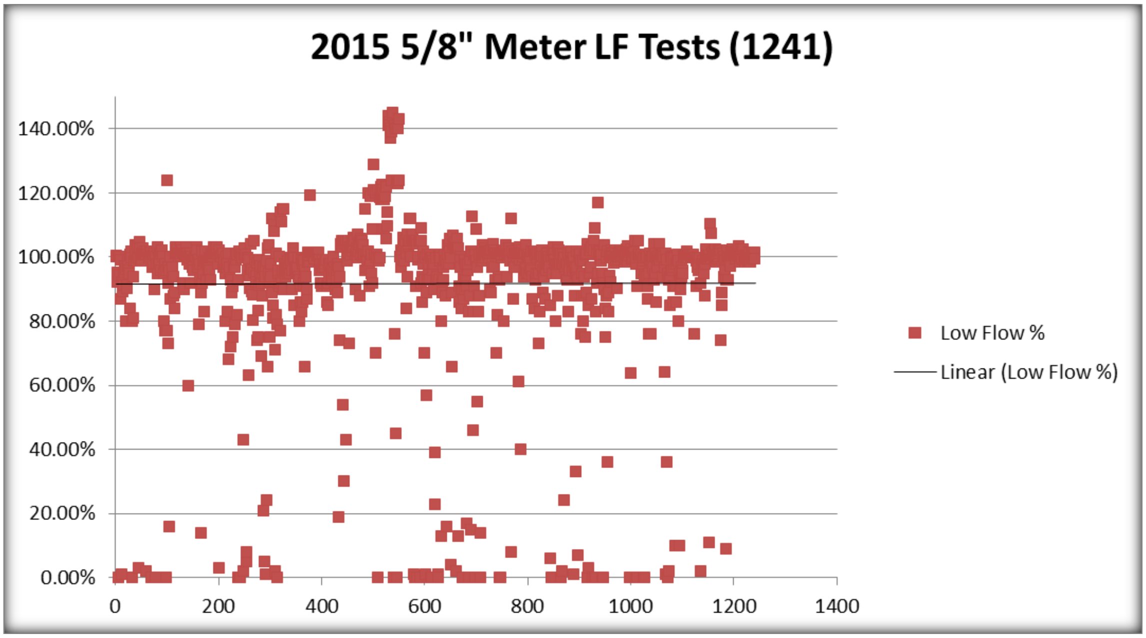


Figure 3-1 2015 - 5/8” Low Flow Test Results (1,241 Tests - Avg. 91.7%)

Test results for all 3” and larger meters were previously reported “as left”, so they may not have indicated the accuracy of the meter prior to adjustment (which is very important for meter inaccuracy reporting). It is recommended that a report is generated that identifies failed large meter tests. It is also suggested that the water utilized for testing is tracked on the quarterly internal non-revenue water reports. Because the Department employs three meter testing technicians, the volume of water used for testing is significant enough to track.

3.4.3 Systematic Data Handling Error Estimation

The Department utilizes several automated and human error checking processes for their billing practices. Although billing system reports are sizeable, automatic triggers to track potential data handling errors are built-in to the billing software and forwarded on to staff specifically assigned for addressing potential data errors in the billing process. To the best of our knowledge, there are no systems with zero systematic data handling errors; therefore an estimated value of 2.8% of billed authorized consumption (1,786.244 MG) has been calculated for this input variable. Table 3-8 shows the 2015 validation grade for the apparent loss components. This value was selected do to the complexity of the current billing system as well as possible lag time that can occur in systems this size. The installation of AMI meters will reduce the systematic data handling errors for future audits.

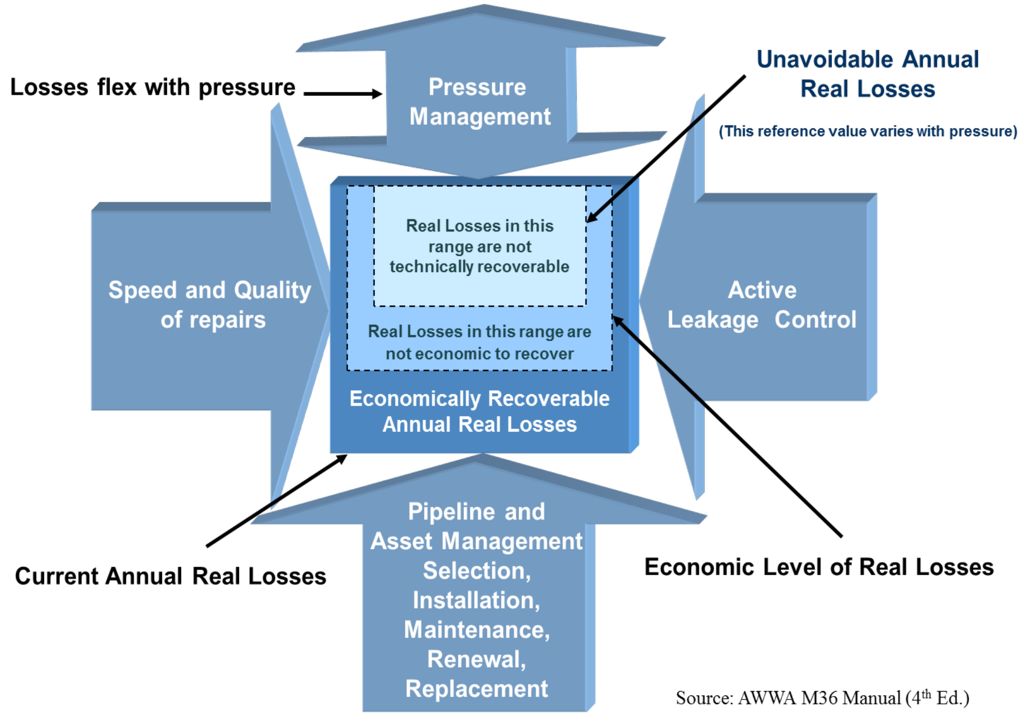
Table 3-8 Apparent Water Losses Validation Grading

GRADED VARIABLE	GRADING	REASONING
Unauthorized Consumption	5	The default was used for this variable
Meter Inaccuracies	7	A detailed testing program was initiated for 5/8-inch meters in 2012. Additional testing on other sized meters was conducted in 2013 to continue with program. The audit grade will increase as the number of tests (including 1”-2”) increase.
Data Handling Errors	5	This is an estimate assuming a complex billing system

3.5 Real Losses

In the AWWA software the real loss value is the remainder, or what is left over after all the other variables (water supplied, authorized consumption, and apparent losses) are calculated. In order to provide a better estimate, a review of system data and the leak detection program operated by the Department’s Water Distribution Division was conducted. These values are matched to the software real loss calculation to act as a validation tool.

There are four intervention activities that can be undertaken to reduce real losses: 1) active leakage control, 2) pipeline and asset management, 3) speed and quality of repairs and 4) pressure management. Figure 3-2 provides a diagram of these four ways to reduce loss. Pipeline and asset management includes installation, maintenance, renewal, replacement and selection. The Department continues to conduct a pro-active leak detection program including large diameter pipe assessments by Pure Technologies Inc. during 2015. At this time, the Department does not plan to conduct pressure management to reduce leakage. Due to the increase in leaks found during 2015, the leak repair crews are often unable to keep pace with the leak locating crew. There are currently 200 plus leaks reported that are more than 90 days old.



Source: AWWA M36 Manual (4th Ed.)

Figure 3-2 Four interventions to reduce real loss

The Department personnel maintain and repair all leak detection equipment. When a system survey is completed, all equipment undergoes a preventative maintenance program for 2 months following the survey. This is in addition to the maintenance and repair that occurs during the 10 months the survey is taking place. A list of equipment used on a daily basis is outlined in Table 3-9 and 3-10.

Table 3-9 2015 Leak Survey Equipment

LEAK SURVEY EQUIPMENT
Fixed Network System • ZoneScan • SEBA N-3
Sepem Loggers
Enigma Correlator
Permanet+ Mobile Network

Table 3-10 2015 Leak Pinpointing Equipment

LEAK PINPOINTING EQUIPMENT
Sure Lock
AquaScope Ground Microphone
Fuji LD10 Ground Microphone

Fuji LD 15
Aqua 3600 Correlator
Sewerin Correlator
Sewerin Stethascope
Geophone

As previously mentioned, unreported leaks (detected by active leak detection) increased from 1,240 in 2014 to 1,491 in 2015. Total leaks tracked in 2015 were 3,041. The 2015 leak information did not include hydrant leaks. The average GPM was calculated by dividing the estimated leakage by the number of leaks, by the days in each quarter, by hours in each day, and by minutes in each hour. The leaks documented included BG (Breaking Ground) and NBG (Non Breaking Ground) leakage. Table 3-11 below documents the estimated leakage documented in the quarterly non-revenue water report. This value was derived from the data request and cross checked with the non-revenue report received from the leak detection personnel during the site visit. The Departments leak calculations are based on the variable of type and size of leak measured during repairs and the non-variables that each leak has run for 180 days with a constant pressure of 55 psi. All leakage is calculated to have been running for 180 days unless the leak is caused by a contractor. There is no accurate way to estimate leakage as the run time is a variable that can't be identified with certainty. The protocol used by the Department (measure leak and calculate at system pressure based on actual measurement) is good practice.

Table 3-11 Estimated leakage from internal non-revenue report

2015 BY QUARTER	EST. GALLONS / LEAKAGE	# OF LEAKS	AVG GPM PER LEAK/QTR
1st Quarter	3,570,491,852	884	31
2nd Quarter	2,976,820,268	809	28
3rd Quarter	3,364,777,047	712	36
4th Quarter	744,523,631	636	9
Estimated Total	10,656,612,798	3,041	26

Figure 3-3 below indicates that 62% of all leakage reported in 2015 was service line leakage. For additional leak data, see Appendix E.

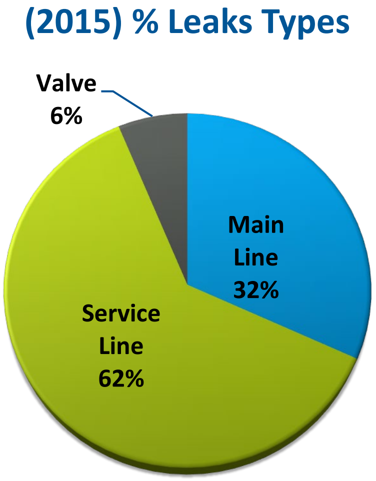


Figure 3-3 2015 Leaks (3,041)

3.5.1 Quarterly Non-Revenue Reporting

Table 3-12 lists the monthly and quarterly leak estimates as documented on the internal non-revenue report as well as the quarterly leak spreadsheet provided by leak detection personnel during the final site visit.

Table 3-12 2015 Leakage Water Recovery

LEAKAGE WATER RECOVERY		
Month	**Water Accountability**	**Trouble - Section**
Jan	675,533,472	372,165,708
Feb	643,642,756	623,665,996
Mar	968,279,428	287,204,492
Qtr 1	**2,287,455,656**	**1,283,036,196**
Apr	802,956,249	274,241,658
May	523,610,032	510,687,058
Jun	660,091,013	205,234,258
Qtr 2	**1,986,657,294**	**990,162,974**
Jul	1,046,446,435	140,555,671
Aug	646,475,329	538,629,331
Sep	703,803,507	288,866,774
Qtr 3	**2,396,725,271**	**968,051,776**
Oct	467,255,161	259,961,615

Nov	791,631,944	162,213,858
Dec	520,378,122	322,348,158
Qtr 4	**1,779,265,227**	**744,523,631**
Total	**8,450,103,448**	**3,985,774,577**
Monthly AVG.	704,175,287	332,147,881

In addition to the standard detection activities, the Department also conducted pilot studies of two types of acoustic leak noise loggers in 2013/2014. The loggers were tested to gauge their effectiveness and operational capabilities in areas which were normally difficult to access or had issues for survey crews to perform leakage detection during normal conditions. The pilot programs proved to be highly effective. The Department now utilizes two different logger and fixed networks with plans to expand to additional areas where the lift and shift is deemed too dangerous. During 2015, there were no pilot programs conducted by the leak detection program. Protocols developed from previous year pilot studies have been implemented into the leak detection program.

2015 Total Real Water Losses = 23,782.942 MG

3.6 System Data

3.6.1 Length of Mains

As previously mentioned, the Department's water system consists of three regional water treatment plants, the South Dade Water System, treated water storage and pumping facilities, and approximately 7,941 miles of water transmission, distribution and service pipelines including wholesale customers. The retail transmission and distribution portion includes 6,035 miles and is the value used in the audit. This value is slightly higher than the 2014 pipe inventory (5,947 miles). The leak detection crew state that they conduct leak surveys on approximately 8,000 miles of pipe per year (10 months surveying and 2 months of equipment preventative maintenance).

3.6.2 Number of Service Connections

The number of service connections includes both active and inactive service lines. This value was calculated as 459,202 active and inactive connections in 2014. The 2015 value was derived by adding the quarterly customers billed and then averaging the quarterly summed totals for each quarter of the year (billed quarterly). The customers billed in 2015 were sorted by residential and non-residential customers (Table 3-13). To estimate the number of non-active service connections, 0.5% of the calculated active connections was factored (2,387). The number of active and inactive service connections increased to 479,785 in 2015.

Table 3-13 Active and Inactive Service Connections

CONNECTION TYPE	# OF CONNECTIONS
Residential Connections	429,445
Non-Residential Connections	47,953

Inactive Connections (.5%)	2,387
Total Active and Inactive Service Connections	479,785

3.6.3 Average Length of Customer Service Line

The average length of customer service line is zero (note that the distance from the main to the property boundary has already been factored in to this calculation, and so the distance is 0 feet). See Figure 3-4 for a diagram of a typical residential service line configuration.

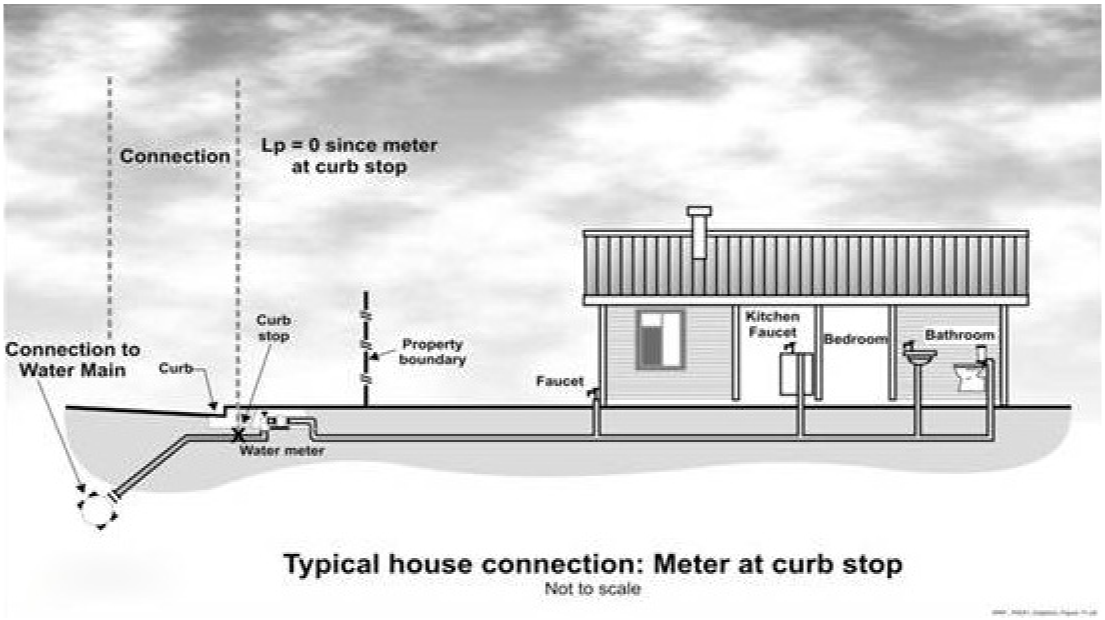


Figure 3-4 Average length of Service Line, Meter at the Curb Stop (source: AWWA Software)

3.6.4 Average Operating Pressure

The average operating pressure of 55 psi was input for the 2015 audit. This value was used based on the leak detection personnel's understanding of the pressures and hydraulic data. Table 3-14 below lists the location and 12 month average of pressure monitors (information provided for 2013 & 2015) installed throughout the system. Reliable pressure information was not received for 2014. Due to the topography, there is very little pressure change. It is recommended that the Department evaluates the pressures noted at the 186th St. and W. 60th St. locations to determine why there appears to be substantial pressure variances at these locations.

Table 3-14 Pressure monitor locations (12 month AVG)

PRESSURE MONITOR LOCATION	12 MONTH AVG PSI (2013)	12 MONTH AVG (PSI 2015)
112 St	50.79	43.93
186 St	66.86	47.76
199 St	58.54	57.42

209 St	57.47	55.40
PS0682	63.65	63.00
Airport	60	61.58
Aventura	57.5	55.90
Bal Harbour	60.04	59.55
Broad Cswy	65.61	64.81
Byron Ave		59.77
Downtown	62.5	62.67
Key Biscayne	59.79	59.82
NE 161 St	58.56	55.58
Normandy	60.68	58.56
Norwood	61.89	62.13
PS 0698	56.78	56.06
San Marco	61.1	56.37
SDWWTP	46.69	
SW 152nd St	57.26	57.31
W 60 St	49.08	61.03
Watson Is.	60.39	62.27
12 Month Average	**58.759**	**58.046**

For the 2014 water audit, analysis of the hydraulic model was also conducted. This provided a value of just over 56 psi. However, since 55 psi is used in all water loss calculations conducted by field staff, it was decided that the difference was not great enough to warrant a change. The value of 55 psi was also used for the 2014 audit. Data gathered by the Department's remote pressure monitors revealed a slight increase over the 2014 reported value. The leak crew felt confident that the average pressure was 55 psi based on the hydraulic model and therefore calculates leakage at 55 psi. Because the pressure monitoring location documented in Table 3-14 are not weighted, the pressure of 55 psi was also used for the 2015 audit.

Table 3-15 shows the validation grading for the system data component.

Table 3-15 System Data Validation Grading

GRADED VARIABLE	GRADING	REASONING
Length of Mains	9	Developed through GIS, uncertain protocols for transfer of new data
Number of Services	7	Good billing records, uncertain policies and procedures regarding inactive service lines
Customer Service Line	10	All services at property boundaries (therefore zero (0) value)
Average Operating Pressure	7	Utilized operations average which was near 2013 and 2014 average.

3.7 Cost Data

3.7.1 Total Annual Cost of Operating the Water System

The total annual cost of operating the water system includes operations, maintenance and any annually incurred costs for long-term upkeep of the system, such as repayment of capital bonds for infrastructure expansion or improvement. Typical costs include employee salaries and benefits, materials, equipment, insurance, fees, administrative costs and all other costs that exist to sustain the drinking water supply system. Based on the Department's financial statements for FY 2015 and 2016, the total annual cost of operating the water system was derived from the following components:

- Operations and maintenance incurred costs
- Depreciation costs

Table 3-16 shows the cost of operating the system (water only) comparison from 2014 to 2015.

Table 3-16 Operating Cost Details 2015

TOTAL COST	2014	2015
O&M	$152,873,192	$173,501,657
Depreciation	$65,846,584	$91,237,698
Total Annual Cost	**$218,719,776**	**$264,739,355**

Operation & maintenance expenses (O&M) are listed in Table 3-17. Expenses to produce, treat and distribute water accounted for approximately 58% of O&M in 2015 per Table 3-18. As a result, customer accounting, customer service, and general & administrative expenses were calculated at 58% also. Sewer represents 42% of these accounts and was not factored into this component. The values for 2014 included 100% of the value for customer accounting, customer service, and general & administrative. Depreciation on pump station structures was calculated at 58% on the 2015 quarterly income statements. Table 3-17 lists the breakdown of the operating costs for 2014 and 2015 and Table 3-18 portrays the quarterly breakdown of O&M expenses for 2015.

Table 3-17 Operating Costs Comparison (2014/2015)

OPERATING COSTS COMPARISON	2014	2015
Water Source of Supply	$11,122,989	$10,403,632
Water Pumping	$2,068,830	$1,941,661
Water Treatment & Purification	$59,975,202	$66,492,123
Water Transmission & Distribution	$29,904,232	$30,075,522
Customer Accounting	$3,173,101	$3,264,812
Customer Service	$10,038,132	$12,873,432
General & Administrative	$36,590,706	$48,450,475
Total Annual Cost	**$152,873,192**	**$173,501,657**

Table 3-18 2015 Quarterly Cost Details ($173,501,657.56)

O & M EXPENSES	1ST QUARTER	2ND QUARTER	3RD QUARTER	4TH QUARTER	TOTAL
Water Source of Supply	$2,276,756	$2,461,269	$3,969,387	$1,696,220	$10,403,632
Water Pumping	$664,496	$217,783	$634,749	$424,633	$1,941,661
Water Treatment & Purification	$15,983,803	$15,848,930	$16,994,713	$17,664,677	$66,492,123
Water Transmission & Distribution	$7,244,323	$7,300,617	$8,421,299	$7,109,283	$30,075,522
58% of Customer Accounting	$807,105	$838,152	$787,507	$832,048	$3,264,812
58% of Customer Service	$3,762,174	$2,438,683	$3,547,336	$3,125,239	$12,873,432
58% of General & Administrative	$12,946,633	$13,675,102	$11,348,196	$10,480,544	$48,450,475
Quarterly O & M Expenses	**$43,685,290**	**$42,780,536**	**$45,703,187**	**$41,332,644**	**$173,501,657**

A comparison of depreciation is noted on Table 3-19 below.

Table 3-19 2014/2015 Depreciation Comparison

DEPRECIATION	2014	2015
Deprec – Pump Station Structures	$12,790.334	$24,789,785
Deprec – Water Transmis & Distri	$39,740,979	$41,663,193
Deprec - OFFSET -Common Fund	$2,918,795	0
Deprec – Treatment & Plant Oper Equ	$5,531,411	0
SCADA Equipment	$37,264	$5,866,694
Deprec - Wtr Mtrs, Bckflw Prev Eq	$652,763	$3,185,213
Deprec – Personal Prop-Non-Auto	$1,689,691	$1,833,508
Deprec – Utility Plant Acq Adj	$1,685,977	$10,895,355

Deprec – Automotive Equipment	$799,370	$3,003,946
Depreciation Per Year	**$65,846,584**	**$91,237,698**

Because the Department operates on an October through September fiscal year, financial statements from FY 2015 and 2016 were utilized to develop calendar year 2015 financial data. The full annual cost utilized for the audit is the total operating costs including O&M and depreciation. The total cost of operating the water system increased by $20.628 million between 2014 and 2015. Depreciation increased from $65,846,584 (2014) to $91,237,698 (2015). Much of this increase of $25.391 million is due to calculating 58% of the depreciation on the pump station structures. This 58% represents the percentage of depreciation costs for accounts that include water and sewer.

In 2015 the overall cost of running the water system (including depreciation) was $264,739,355.

3.8 Customer Retail Unit Cost

Customer retail unit cost represents the weighted average of individual costs and number of customer accounts of each class. This is calculated as annual retail revenue divided by annual retail sales volume. Total retail water revenue is utilized however, in order to calculate volumetric based water sales unit cost. The Department's meter base charge revenue and unread/unbilled water revenues are removed isolating the volumetric based water sales for the calculation of customer retail unit cost. Retail water sales less these items for 2015 were approximately $205.9 million. Table 3-20 lists the quarterly retail sales sorted by customer type.

Table 3-20 2015 Quarterly Retail Water Sales

RETAIL UNIT COSTS	1ST QUARTER	2ND QUARTER	3RD QUARTER	4TH QUARTER	2015
Residential	$14,453,599	$18,682,056	$15,149,298	$16,177,591	$64,462,546
Multi-Family	$9,754,965	$5,573,521	$7,470,160	$8,411,568	$31,210,216
Res - Sprinkler	$1,632,416	$1,165,558	$1,641,646	$1,278,739	$5,718,360
Commercial	$19,622,982	$23,974,445	$23,327,217	$26,326,379	$93,251,025
WASD Wtr Facility	$105,945	$105,096	$93,986	$131,292	$436,320
Non-ResSrink-Wtr	$2,877,235	$2,452,278	$2,926,126	$2,675,551	$10,931,192
Marina - Water	$24,923	$32,272	$29,292	$17,303	$103,792
Firelines	$54,700	$20,189	$-25,356	$117,075	$166,608
Wtr Rest Surcharge	$-335,473	$-8,878	$-8,789	$-473	$-353,615
Total					$205,926,447

Table 3-21 lists the summary of retail cost comparison from 2014 to 2015 for each customer category.

Table 3-21 Retail Unit Cost 2014 and 2015

RETAIL UNIT COST	2014	2015
Metered Sales – Residential-WTR	$62,126,908	$64,462,546
Metered Sales – Multi Family-WTR	$27,735,528	$31,210,216
Metered Sales – Res Sprink-WTR	$5,124,614	$5,718,360
Metered Sales – Commercial-WTR	$90,231,118	$93,251,025
Metered Sales – WASD WTR Facility	$432,555	$436,320
Metered Sales – NonResSprink-WTR	$9,115,692	$10,931,192
Metered Sales – Marina-WTR	$112,485	$103,792
Metered Sales - Firelines	$267,937	$166,608
Wtr Conservation Surcharge/Excess Water Usage	$108,101	-$353,615
Total Retail Water Sales	$195,254,939	$205,926,447
Billed Water (x 1000 gallons)	63,470,026	63,794,433
Retail Unit Cost of Water Sold (per 1000 gallons)	**$3.08**	**$3.23**

Total billed water for 2015 was approximately 63,794,433 thousand gallons. Customer retail sales divided by the associated billed water for 2015 results in a customer retail unit cost of $3.23 per thousand gallons. While the amount billed increased in all units except Marina-Water and Firelines, the increase in customer retail unit cost for 2015 is likely due to increases in Multi-Family and Commercial Water billed as well as rate increases that went into effect on October 1st, 2014 and October 1st, 2015.

The Department has an inclining block water conservation rate structure for all its residential customers. Table 3-22 below shows the current volumetric rate structure for single family residential customers.

Table 3-22 Fiscal Year 2014/2015 Residential Water Volumetric Rate (per 100 Cubic Feet)

RESIDENTIAL USAGE RATES	2014 RATE	2014 RATE (EFFECTIVE 10/1/2015)	2015 (EFFECTIVE 10/1/2015)
0 to 5 CCF	$0.37	$0.37	$0.37
6 to 9 CCF	$2.53	$2.75	$3.01
10 to 17 CCF	$3.15	$3.34	$3.56
18 CCF and over	$4.17	$5.53	$5.88

All four tiered rates for residential, multi-family, and non-residential are the same, but the rates apply to different usage volumes (Tables 3-22 and 3-23).

Table 3-23 Fiscal Year 2014/2015 Multi-Family Residential Water Volumetric Rate (per 100 Cubic Feet)

MULTI-FAMILY USAGE RATES	2014 RATE (EFFECTIVE 10/1/2015)	2015 (EFFECTIVE 10/1/2015)
0 to 4 CCF	$0.37	$0.37
5 to 7 CCF	$2.75	$3.01
8 to 14 CCF	$3.34	$3.56
15 CCF and Over	$5.53	$5.88

For a complete list of the non-residential tiered volumetric rate for all customer classes, see Appendix H. The list includes the rate increase that went into effect October 2014 and October 2015.

For purposes of this audit the retail rate for the majority of 2015 was $3.56 per hundred cubic feet (CCF). Based on the data received, it appears that the average monthly average usage is approximately 9 CCF per month or 27 CCF per quarter for a normal residential customer (residential customers are billed on a quarterly basis). See Table 3-22 and 3-23 above to understand the different rate tiers. In order to further validate this, a review of the metered sales against billed metered water was also conducted and the average of $3.23 per 1000 gallons was used. This value was used as it is a more conservative value of what cost could be recovered. For future audits, a third method can be used for calculating retail rates by calculating the weighted volume of each tier (monthly billing).

3.9 Variable Production Cost

Variable production costs represent the cost to produce and supply one additional unit of water and are estimated as total production costs of the water system. These costs include variable costs i.e. power and pumping, purification, and distribution divided by the total volume of water supplied to the water distribution system including imported water. To see a comparison of variable cost values for 2014 and 2015, see Appendix C.

Variable costs included:

- Electrical services
- Natural gas
- Water and sewer service
- Purchased water
- Calcium carbonate disposal
- Fuel
- Petroleum gas
- Hazardous waste disposal

- Chemicals
- Laboratory supplies
- Gases
- And others

Total variable production costs were estimated to be approximately $37.09 million in 2015. Table 3-24 breaks out the variable costs for 2014 and 2015.

Table 3-24 Variable Production Cost 2015 (comparison)

LINE	VARIABLE COST	2014	2015
1	Water Source of Supply	$4,251,986	$2,096,967
2	Water Pumping	$1,418,675	$1,270,755
3	Water Treatment and Purification	$28,481,936	$32,688,807
4	Water Transmission and Distribution	$1,827,615	$1,042,854
5	**Total Variable Cost**	**$35,980,212**	**$37,099,383**
6	Finished Water (MG)	110,364	113,839
7	Purchased Water (MG)	152	124
8	**Total Water Supplied**	**110,516**	**113,963**
9	**Cost to Produce 1 Million Gallons of Water**	**$325.56**	**$325.54**

Finished water supplied to the distribution system plus purchased water from the cities of Homestead and North Miami Beach was approximately 113,839 MG in 2015 resulting in a variable production cost of $325.54 per million gallons of water.

The variable production costs include all the costs for pumping, treatment and chemicals used at the treatment plants and were calculated using the financial reports. The variable production costs decreased from 2014 to 2015 by approximately $20,000. Table 3-25 lists the validation grading for the cost data component.

Table 3-25 Cost Data Validation Grading

GRADED VARIABLE	GRADING	REASONING
Total Cost of Operation	9	All costs developed and Third party CPA audited. Since the audit is conducted on a financial year and data constructed in a calendar year, there may be some errors in data transfer.
Customer Retail Unit Cost	8	Used the calculation of metered sales against the total billed metered, this matches relatively well with the average use block ($3.34 per CCF)
Variable Production Cost	8	An evaluation of the financial reports calculating only variable costs

4.0 Water Treatment Plant Losses

As previously mentioned, the Department operates three regional WTPs: Hialeah, Preston, Orr, the Hialeah RO plant and smaller plants that are part of the South Dade Water System. A description of each plant is provided in the subsections below. The overall annual average daily flow of the entire system was approximately 311.89 MGD during 2015. This is slightly more than the 2014 average of 299.2 MGD.

Raw water supply for the three regional treatment plants is currently drawn from 83 Biscayne aquifer wells located in the major wellfields of Miami Springs, Northwest, Medley (which is in stand-by), West, Southwest, Snapper Creek and several wells onsite at the three treatment plants. The South Dade Water System is served by 12 Biscayne aquifer wells located at the five smaller wellfields. Table 4-1 provides a summary of each of the Miami-Dade County permitted Biscayne aquifer wells.

The Hialeah RO plant is owned jointly by the City of Hialeah and the Department. The RO plant has an initial treatment capacity of 10 MGD and it is designed to have an ultimate capacity of 17.5 MGD. This plant commenced production in November of 2014 and the raw water source is the brackish Upper Floridan aquifer.

A new plant is currently under construction and will replace three of the small treatment plants that are part of the South Dade Water System. This plant, slated for completion in 2018, will be a 20 MGD membrane softening and RO plant with the abilities to treat water from the Biscayne and Floridan aquifers. In addition, the Department also has the ability to use ASR wells as a water source. A list of Floridan wells are shown in the Table 4-2.

Table 4-1 Summary of Biscayne Aquifer Wellfields

WELLFIELDS	WTP SERVED	DESIGN CAPACITY (MGD)	NUMBER OF WELLS
Hialeah	Hialeah/ Preston	12.54	3
John E. Preston	Hialeah/ Preston	53.28	7
Miami Springs Upper Lower	Hialeah/ Preston	79.30	 Upper–12 Lower–8
Medley (Stand-by)	Hialeah/ Preston	48.96	Stand-by-4
Northwest	Hialeah/ Preston	149.35	15
Alexander Orr	Orr	74.40	10
Snapper Creek	Orr	40.00	4
Southwest	Orr	161.20	17
West	Orr	32.40	3
South Dade	South Dade Water System	19.01	Leisure City–4 Everglades–3 Elevated Tank–2 Newton–2 Naranja–1
South Miami Heights	South Miami Heights WTP	4.00 6.00	Former Plant-1 Roberta Hunter Park-4

Table 4-2 Summary of Floridan Aquifer Wellfields

WELLFIELDS	WTP SERVED	DESIGN CAPACITY (MGD)	NUMBER OF WELLS	PERMITTED ALLOCATION (MGY)
Southwest Wellfield ASR	Alex Orr	10.00	2	1,522
West Wellfield ASR	Alex Orr	15.00	3	2,283
Hialeah RO WTP	Hialeah RO WTP	20.00	14	4,855
South Miami Heights	New SMH WTP	24.00	7	8,494

The Hialeah and Preston plants pump water into both the high pressure and low pressure distribution systems. The plants are interconnected prior to the high service distribution pumping system and operate a single pumping station. Independent pumping stations at each plant pump into the low pressure system.

Real water losses in facilities that use conventional lime softening processes can account for 3 to 5 percent of raw water supplied. A large portion of this loss can be accounted for by the handling and disposal of residuals. This loss is prior to the finished water meters so not directly related to non-revenue water in the distribution system. Lime softening is the primary treatment of groundwater at the three regional treatment facilities and the residuals generated in the process are comprised almost entirely of calcium carbonate ($CaCO_3$) solids.

The Hialeah and Preston plants discharge the calcium carbonate residuals (lime slurry) from the lime softening process through a 12-in diameter line from the Hialeah plant and a 16-in diameter line from the Preston plant to either the Miami Springs and/or Northwest Wellfield residuals lagoons.

Prior to re-calcination, some of the water is extracted from the solids via centrifugation and returned to the treatment process. Water vaporized during the heating of the solids during re-calcination is not recovered. Small amounts of water are also used (lost) for monitoring plant performance. Water may also be lost via undetected leaks in water treatment plant structures and piping.

In addition to real losses, apparent water loss may also occur as a result of errors in the individual well meters, raw water influent plant Venturi meters, and finished water effluent meter readings. Analysis of the metered raw water flows and finished water flows for the plants is presented in the following sub-sections to quantify the overall water losses at the Orr, Hialeah RO, and Hialeah/Preston plants. Although large quantities of water are used in the process for backwashing filters, feeding chemicals, etc., the majority of this water is recycled back into the treatment process. Since all large process recycle streams occur internal to the plant, these flows are not measured twice by either the raw or finished water venturi meters.

4.1 Raw Water Flows

Raw water flows continued to be measured both at each individual well in the system and entering the treatment plants.

4.1.1 Alex Orr Water Treatment Plant

Tables 4-3 and Figure 4-1 below compare the raw water flows (MG) metered at the well fields and the raw water flows metered at the plant.

Table 4-3 Alex Orr WTP Raw Water Flows

MONTH	SUM OF INDIVIDUAL WELL FLOWS	RAW WATER PLANT FLOWS	VOLUME DIFFERENCE	PERCENT DIFFERENCE
January	5,591	5,175	416	7%
February	4,945	4,594	351	7%
March	5,680	5,407	273	5%
April	5,239	5,323	216	4%

May	5,761	5,488	273	5%
June	5,686	5,437	249	4%
July	5,834	5,658	176	3%
August	5,771	5,527	244	4%
September	5,068	5,273	-205	-4%
October	5,633	5,466	167	3%
November	5,585	5,382	203	4%
December	6,073	5,775	298	5%
2015 Avg	**5.597**	**5.375**	**222**	**4%**

At the Orr plant the sum of each individual raw water flow registered on average 4 percent per month higher than measured at the plant raw water influent venturi meters. This is a reflection of both under/over registration and meter inaccuracies. These totals reflect the sum of 38 individual meters (34 remote well meters and 4 raw water venturi meters at the plant). In 2014, the average was also 4 percent higher per month.

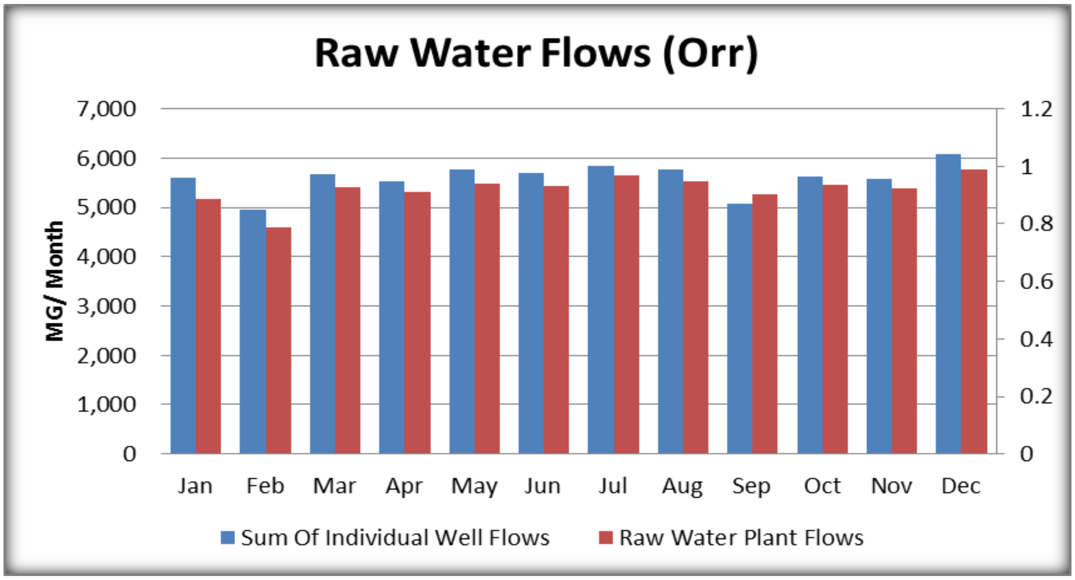


Figure 4-1 Alex Orr WTP Raw Water Flows

4.1.2 Hialeah and John Preston Water Treatment Plants

The Hialeah and Preston plants receive a combination of flows from both the Northwest and Miami Springs (Upper and Lower) wellfields in addition to the wellfields located within the plant sites.

Tables 4-4 and Figure 4-2 compare the raw water flows in MG metered at the well fields and the raw water flows metered at the Hialeah and Preston plants combined.

Table 4-4 Hialeah & Preston WTPs Combined Raw Water Flows

MONTH	SUM OF INDIVIDUAL WELL FLOWS	RAW WATER PLANT FLOWS	VOLUME DIFFERENCE	PERCENT DIFFERENCE
January	4,253	4,208	45	1%
February	3,885	3,854	31	1%
March	4,348	4,321	27	1%
April	4,257	4,254	3	0%
May	4,252	4,082	170	4%
June	4,054	3,871	183	5%
July	3,958	3,940	18	0%
August	3,858	3,875	-17	0%
September	3,798	3,777	21	1%
October	4,031	4,063	-32	-1%
November	3,820	3,821	-1	0%
December	3,794	3,803	-9	1%
2015 Avg	**4,026**	**3,989**	**37**	**1%**

The Hialeah/Preston water treatment plant combined sum of individual well raw water flows reflects both under/over registration throughout the year. However when looking at the total raw water pumped in 2015 from the wells and raw water entering the plants, the difference is 1% as opposed to 3% in 2014. The monthly under/over registration of these totals reflect inherent meter inaccuracies (sum of 50 individual meters; 45 remote well meters and 5 raw water venturi meters at the two plants).

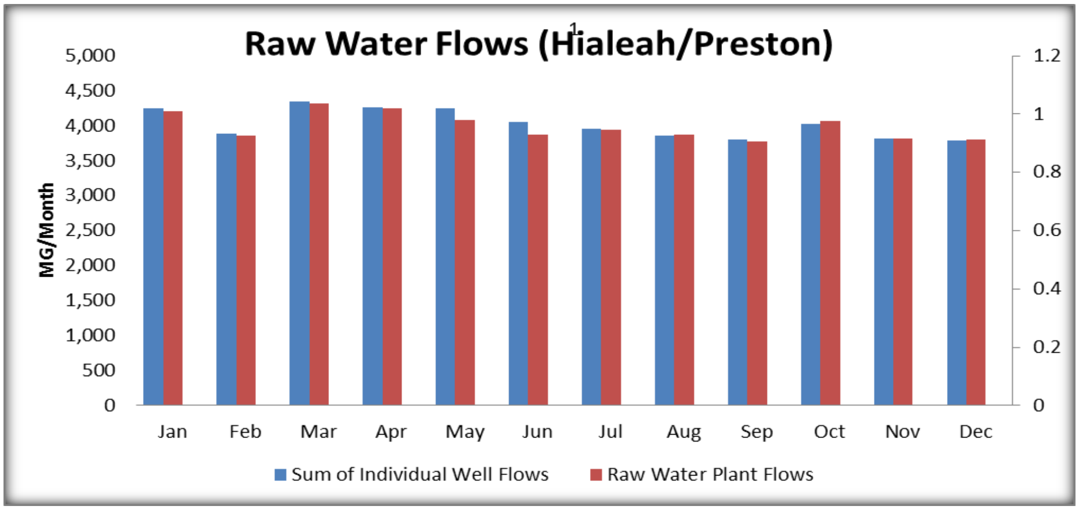


Figure 4-2 Hialeah/Preston Combined Raw Water Flows

4.2 Treated Water Flows

The section below discusses the raw water at the Preston and Hialeah treatment plants separately. The analysis illustrates how inaccurate the flows are at each plant. Because raw water flow at the Preston plant is more than the treated water, and the raw water flow at the Hialeah plant is less than the treated water, the combination of the two plants is more accurate than each individual plant.

4.2.1 Hialeah and Preston Water Treatment Plants

Results presented in Figure 4-3 indicate that the raw water influent flow was on an average 12% more per month than the metered treated water at the Preston Plant.

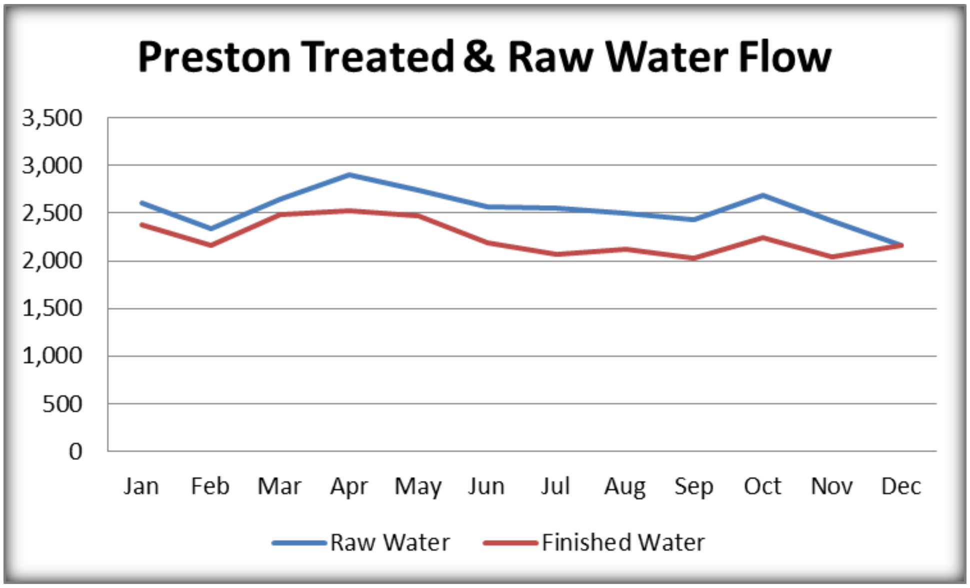


Figure 4-3 WTP Difference between Treated and Raw Water Flows

Figure 4-4 indicates that the raw water influent flow was on average 14% per month lower than the treated water flow metered at the Hialeah Plant.

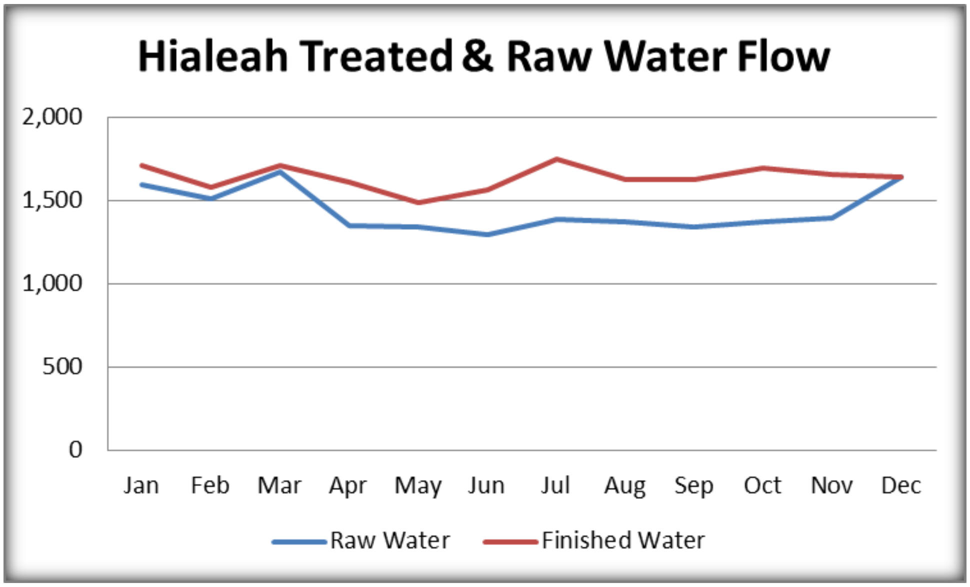


Figure 4-4 Hialeah WTP Difference between Treated and Raw Water Flows

When these two plant flows are combined and added up, the results indicate that, on average, there is a three percent water loss through the Hialeah/Preston treatment complex. This is shown in Figure 4-5 below. This is consistent with the results reported for calendar years 2012, 2013, & 2014.

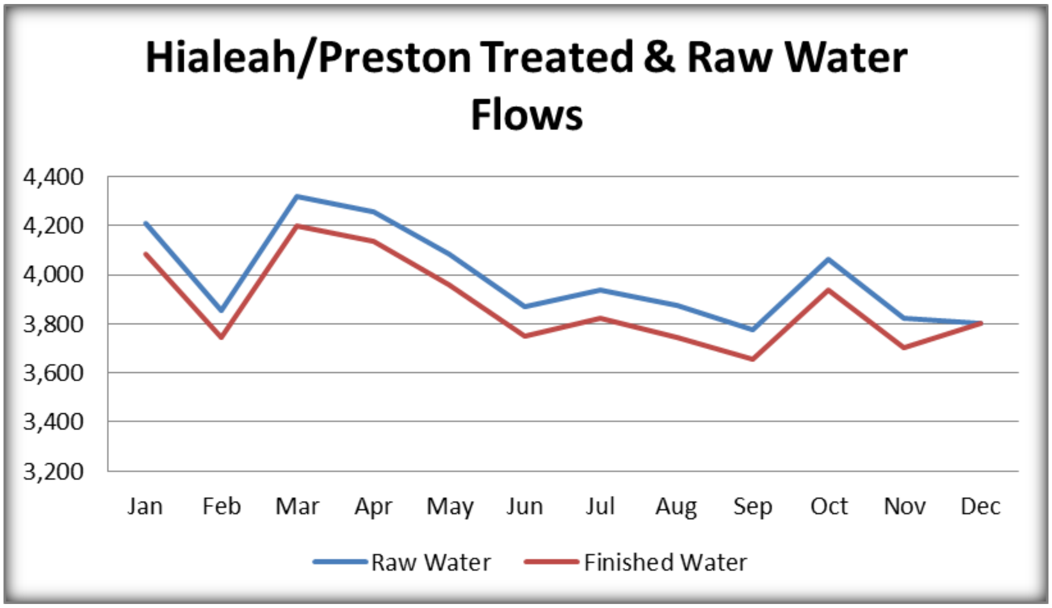


Figure 4-5 Hialeah/Preston WTPs Combined Difference between Treated and Raw Water Flows

The difference in the metered flows for each individual plant reflect the fact that they need to be combined given the hydraulics between them. The Preston plant feeds treated water to the finished water clear well at the Hialeah plant. This inter plant flow is not measured but explains the under-registration of treated water flows metered at Preston and over registration of treated water flows metered at the Hialeah plant.

4.2.2 Alexander Orr Water Treatment Plant

Table 4-5 below indicate that the raw water flows measured at the Orr plant were on average 1% higher than the treated water flows metered at the plant. This represents a water loss well within expected typical losses.

Table 4-5 Orr WTP Treated vs. Raw Water Flows

2015	TOTAL RAW WATER (MGD)	TOTAL FINISHED WATER (MGD)	DIFFERENCE (FINISHED LESS RAW)	% DIFFERENCE
January	5,175	5,097	(78)	-2%
February	4,595	4,524	(70)	-2%
March	5,407	5,329	(78)	-1%
April	5,323	5,248	(75)	-2%
May	5,488	5,410	(78)	-1%
June	5,437	5,362	(75)	-1%
July	5,658	5,579	(79)	-1%
August	5,527	5,449	(78)	-1%
September	5,273	5,198	(75)	-1%
October	5,466	5,388	(78)	-1%
November	5,382	5,307	(75)	-1%
December	5,775	5,697	(78)	-1%

Figure 4-6 indicates that the raw water influent flow was on average 1% per month more than the treated water flow metered at the Orr water treatment plant.

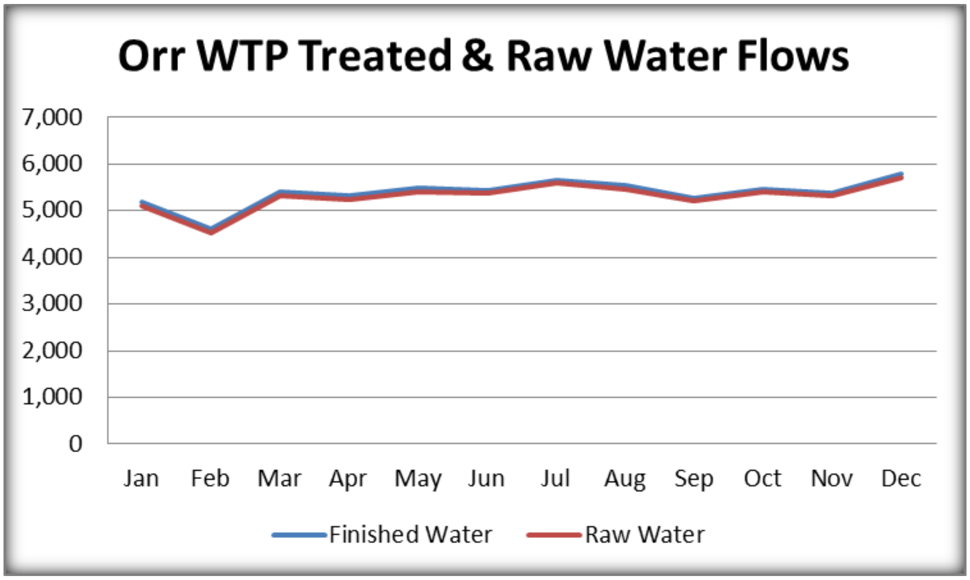


Figure 4-6 Orr WTP Difference between Treated and Raw Water Flows

4.3 Verification and Calibration of Treatment Plant Meters

The analysis and verification of meter accuracy is separated into three sections:

1. Flow Signal
2. Control Loop
3. Repeatability

This structure allows more auditable data and better accounting and transparency of information. A basic review of verification and calibration was conducted in 2014 and calibration was continued in 2015.

4.3.1 Flow Signal Verification

The flow signal verification includes the flow measurement device, which for the Department are all venturi flow tubes. It also includes the impulse lines (the differential pressure flow lines from the venturi meter) and the differential pressure transmitter (currently most are Rosemount units – either 1151 or 3051).

4.3.2 Control Loop Verification

The control loop with respect to flow metering includes the transmission of data from the differential pressure transmitter and all the infrastructure to calculate and store the flow measurement data. This includes the PLCs and SCADA system, all the wiring systems and connections between these units and the data storage within the iHistorian or physical totalizers.

4.3.3 Repeatability Quality Assurance (QA) Process

The 'Repeatability QA process' is required to determine a sequence of analyses which will improve auditing and accuracy of the data. There are standard verification and calibration schedules set within the Flow Signal and Control Loop verification stages.

The Repeatability QA process should include a layered accountability structure that should including the following:

- acknowledgement from field staff that performance of all required procedures have been performed in accordance with the procedures in the adopted SOP's
- acknowledgement from plant supervisory staff that they have reviewed documentation and results and that these are compliant with SOP's and policies

4.3.4 DP Transmitter Calibration Procedure and Documentation

Calibration should be conducted in laboratory conditions with stable temperature, humidity and low levels of dust or other particulates. This can be conducted in Department's facilities if the correct and calibrated (traceable) equipment is used. It should not be conducted in the field. It is expected that this will be conducted by the manufacturer or a qualified third party at least during the initial stages of this assessment. Full bench calibration documentation data, inclusive of NIST traceability compliance statements must be included in the documentation package associated with the Repeatability QA Process.

4.3.5 Treatment Plant Venturi Accuracy

Review of verification and calibrations sheets provided suggests that all the venturi meters are within accuracy tolerances with respect to electronic verification practices.

4.4 Conclusions - Hialeah/Preston WTPs

Combined flows indicate (Figure 4-5) that, on average, there is approximately a 1% percent water loss through the Hialeah/Preston treatment complex. This is slightly more accurate than the results reported for calendar years 2012, 2013 and 2014 for the combined plants. This volume of loss is more commensurate with typical water losses through conventional treatment plants. However, the actual accuracy at each plant individually is less than the plants combined.

Calibration certificates were received for several of the Orr venturi meters (#2 and #5) for tests completed in 2015. All meter calibrations passed the relevant metrics. Table 4-6 lists all tests completed in 2012 and 2013. For the 2016 audit, it is recommended that all test results are provided to allow for a thorough updated evaluation of all plant meter calibrations and include as-found data.

Table 4-6 Venturi Meter Calibration Results: Raw and Finished Water

LOCATION	METER DESCRIPTION	"AS LEFT 2013" (AVG % VARIANCE)	"AS LEFT 2012" (AVG % VARIANCE)
Orr	Finished Water #1	-0.102%	-0.112%
Orr	Finished Water #2	0.076%	0.006%
Orr	Finished Water #3	-0.008%	-0.002%
Orr	Finished Water #4	-0.068%	0.032%
Orr	Finished Water #5	-0.136%	0.01%
Orr	Raw Water #1	0.3%	0.07%

Orr	Raw Water #2	0.08%	-0.042%
Orr	Raw Water #3	0.092%	-0.068%
Orr	Raw Water #4	0.252%	0.000%
Hialeah	Finished B Flow Meter	0.24%	0.2618%
Hialeah	Finished Low Pressure #4	0.02%	0.001%
Hialeah	Finished Low Pressure #5	-0.01%	-0.01196%
Hialeah	Finished Water Miami Springs	-0.10%	0.19036%
Hialeah	Raw Water #1	0.04%	0.0444%
Hialeah	Raw Water #2	-0.07%	0.0323%
Preston	Raw Water #1	0.09%	0.00%
Preston	Raw Water #2	0.81%	0.02%
Preston	Raw Water #3	0.45%	0.13046%
Preston	Finished Water #1	0.24%	0.088%
Preston	Finished Water #2	-0.19%	0.02%

5.0 Results

PIs are an important measurement tool utilized to make sure that the utility is on track with respect to operational practices and water loss reduction both internally and in comparison to similar sized utilities. The new standard methodology itemizes each major aspect of water loss and isolates specific categories. This allows for more detailed and accurate reporting and specific targeting of volume and cost of losses, thereby allowing targeting of resources to the areas most in need.

The Department appears to have reasonable performance as determined and recorded in Table 5-1. However, there are a number of variables such as the unauthorized use and unbilled unmetered consumption which still need to be calculated in future years to further validate these figures.

Table 5-1 PIs Calendar Year 2015

PERFORMANCE INDICATOR	VALUE	UNITS
Validation Grading	77	out of 100
Non-revenue water as percent by volume of Water Supplied:	30.6%	%
Apparent Losses per service connection per day:	20.47	Gallons per connection per day
Real Losses per service connection per day:	133.86	Gallons per connection per day
Infrastructure Leakage Index	11.16	Dimensionless
Annual Cost of Apparent losses	$11,580,191	$
Annual Cost of Real Losses	$7,631,250	$

5.1 Real Water Loss Goals

The Department's efforts to track and repair water main breaks is equal to or above industry averages. There are areas that could be improved in the three components of leak detection: awareness, location, and repair.

The Department's real loss PIs included real loss in gallons per service connection of approximately 134, and Infrastructure Leakage Index (ILI) which is estimated to be approximately 11.16. ILI is a dimensionless ratio of the Current Annual Real Losses (CARL) to the Unavoidable Annual Real Losses (UARL). It is a function of the number of miles of pipe, number of connections, and pressure in the system. Each of these variables has an effect on the leakage – as the value for miles, number of connections, and pressure increase, the UARL will also increase. More details regarding calculation of the ILI can be found in AWWA manual M36 (fourth edition, 2016) and the AWWA free Water Audit Software.

Based on 2010 to 2012 benchmark data from the AWWA Water Audit Data Initiative, the average utility reported real loss of 63 gallons/connection/day.[1] As another point of comparison, an ILI value

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[1] Alan Plummer Associates, Inc. and Water Prospecting and Resource Consulting, LLC, January 24, 2007. *Final Report: An Analysis of Water Loss as Reported by Public Water Suppliers in Texas*, prepared for the Texas Water Development Board.

of 3 is considered reasonable for utilities in the United States who have similar resource needs compared with the Department.[2]

5.2 Apparent Water Loss Goal

Apparent loss is water that is being used by the utility but not billed. Reducing apparent loss does not reduce water use, but does enhance utility revenue. For the Department, estimated apparent losses are approximately 20.47 gallons/connection/day. Based on the AWWA National Water Audit Data Initiative (WADI), from 2010 to 2012 the average utility reported apparent loss of approximately 10 gallons/connection/day. The Department has improved in this area during 2015 as the 2014 value was 22 gallons per connection per day. It is theoretically possible to reduce apparent losses to zero, but this will not be possible due to the size and complexity of this system and the amount of funding that would be necessary.

The combination of best management practices and recommendations, which are proposed to improve the billing system, reduce meter inaccuracy, and further reduce leakage, can have a significant positive financial effect in the short-term. The program can start with a relatively small capital investment to research and reduce the billing inconsistencies and inaccurate meters. The resulting additional revenue can then be used to help enhance the meter replacement and leakage detection program.

The targets discussed in the previous section are excellent medium to long-term goals. However, a roadmap is needed to reach these goals. The recommended management strategies are the beginning of the process. These strategies should be reviewed at least every five years, preferably every two years to re-assess their effectiveness.

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[2] AWWA Manual M36

6.0 Recommendations

There are many on-going activities which the Department will continue to conduct during the next audit year. These will include active leakage detection, testing and replacement of under-performing meters and testing and re-calibration of the production meters. In addition to these normal operational improvements it is recommended that the following programs are conducted in 2016:

1. Continued replacement of the old galvanized service lines. This will have a significant effect on reducing water loss in the distribution system. As identified by the leak detection team, the majority of main line leaks occur on 2” galvanized main lines
2. Continue to develop an in-house leak detection data management program to allow the intensive assessment needed to evaluate a component analysis. Currently, the leak detection program is locating more leaks than crews can repair. Because of this, a substantial back-log exists. It is recommended that the leak detection crew classify leaks during the pinpointing process. Currently, small leaks are treated the same way as large leaks. By prioritizing leak repairs, the Department should be able to substantially reduce the real losses identified by the leak detection program
3. The Department has completed recommended pilot programs and should now focus on areas where leak noise loggers are installed on fixed network systems. This strategic survey method is good practice as it allows the Department to survey areas of high traffic. To further define strategic survey areas, it is recommended that a failure analysis be completed during each repair and all information from the pipeline surveyed to the failure analysis is managed in a way that allows for quick reports to be generated on all leak details
4. The Department should consider tracking all details with GIS as mapping unreported leakage often times reveal system details that are not easily identified by entering data into a database. By enabling reports to be easily generated from the EAMS or GIS systems, the Department will be able to complete historic analysis that will assist in program efficiency decisions
5. Create a pilot DMA zone. This project was considered in 2015 by the Department, but was not undertaken. The basic structure of a DMA includes one unit of the distribution system that is ready made for a district analysis (one supply pipe with existing metered connection). The project would achieve the following goals:
   a. To comparatively analyze the effectiveness of a standard acoustic water leak survey (survey tool and ground microphones) versus logging systems and minimum night flow analyses. The leak detection program has run a comparison of standard manual surveys against lift and shift logger surveys. The test was completed to gain an understanding of the spacing needed to make logger surveys comparable to point to point manual surveying. The test results identified strategic areas to deploy loggers permanently to increase the efficiency and effectiveness of the leak survey. Comparing all three protocols will enable the Department to prioritize and plan surveys

   b. Continue to evaluate the data from the currently installed fixed network system and use this data to perform a water loss analysis in zones where possible. Because of the high traffic in numerous areas, it is likely that additional areas should be considered for permanent installations of leak monitoring equipment (if cost justified)

c. Theoretically analyze the effectiveness of pressure management

Water loss from the system will only be determined after field validation is conducted through measurements such as minimum night flows in DMAs. In the short- to medium-term the knowledge with respect to real losses can be improved by more detailed evaluation of the metering and billing systems to improve the estimations of apparent losses (and so reduce the error in the remainder which is real loss).

It is recommended that protocols continue to evolve to increase the validity of all audit components. The initial review of the Audit Software results highlighted the following as possible issues

a. Continue to increase the validity of data – a number of the data evaluations were estimates which need additional work to prove and validate. Additionally, the Department tested more large customer meters during 2015 while replacing large problematic wholesale meters. This shows the Departments commitment to reduce apparent losses and increase the audit validation, but additional work still needs to be done

b. Leakage – There is a relatively large real loss volume expected to be leakage. Distribution and Transmission main leakage surveys will continue to be needed

c. Meter accuracy – more analysis needs to be conducted annually to improve meter accuracy. Testing data needs to be evaluated, replacement programs analyzed and a detailed testing program for 1" to 2" meters initiated. In 2015, the utility has strived to improve large meter accuracy by increasing the frequency of testing on large customer meters as well as wholesale meters. Large customer meters (3" and larger) will be tested on an annual basis starting in 2016 instead of the original 3 year rotation basis. Wholesale meters are tested (where possible) bi-annually. Additionally, the implementation of the large customer meter assessment and production meter assessment projects has increased the understanding and validation of information for the 2015 audit. Efforts have been made to reduce apparent loss substantially. Continued efforts will help the Department meet performance goals for this type loss.

d. Billing system accuracy – the relatively large water loss component means that evaluation of customer accounts to reduce apparent loss error from miss-classified or missing accounts is advisable. As part of the meter assessment programs, the billing data for these large meters should continue to be reviewed by third party personnel. This will likely increase the validation of metering components during the 2016 audit.

6.1 Recommended Best Practice Improvements

Recommendations for best practice improvement include:

6.1.1 Reduce Leakage

The Department has an excellent active leak detection program and continues to improve it with additional staffing and continued review of historic data. With respect to unreported leaks (non-surfacing), the Department can reduce water loss by repairing leaks, primarily large leaks, more expeditiously. Once more detailed analysis of the costs and benefits of the leak detection program is performed; actual reduction in water loss can be estimated. If the real losses are still greater than the ILI goal, then additional resources can be used to reduce the survey cycle and improve the leak detection and repair process. This would reduce the run time of unreported leaks and reduce water losses proportionally.

To control leakage to the economic level,[3] an increased level of active leakage control beyond that currently employed by the Department is likely to be required. The current practice of utilizing acoustic noise loggers is excellent practice; however, this will not find all the leakage in a system due to the conflicting noises in a distribution system. Therefore a component of this program should also include field staff conducting acoustic surveys with equipment specifically designed for surveying of water leaks and listening to all hydrants, valves, and fittings in targeted areas. Remote technology is an excellent tool, but it does not act as a total replacement for active surveys. PIs representing the number of leaks, types of leaks, and identification method should be recorded and reported. Additional recommendations include;

1. Continue with the automated (leak noise logger) survey methods as the pilot program proved this to be the most effective survey procedure for the leak detection program
2. Analyze actual leakage for the specific system sectors and determine the costs, benefits and complexities of expanding permanent logger installation surveys to additional areas
3. Conduct additional "bottom-up" analysis of leakage results through testing in district areas to determine effectiveness of survey methods
4. Conduct evaluation of pressure management potential (pressure feasibility study)
5. In an attempt to reduce leak run times for large leaks, it is recommended to add leak prioritization data set to work orders generated in the field. This should be considered a critical step in reducing real loss. The leak crews have expanded to a point where the repair crews are unable to keep up with the repairs. This has created a large back-log of leaks awaiting repair. Reducing leak run-times appears to be an area where the Department can reduce real losses in the most efficient way. Small leaks are currently given the same priority as large leaks. Currently, there are over 200 leaks that have been submitted for repair (meter coupling etc.) over 90 days old. Because there is no classification or prioritization, the repair crew does not know if the leak is a main line leak losing substantial gallons per minute or a drip leak. It is advised that the leak detection crew classify leakage and monitoring repair times, especially on large leaks. To prioritize leak repairs, is recommended that the Department adopt a classification system (shown below) that is easy to evaluate. This will insure that large leaks are not left to run for months at a time

   It is recommended that the Department add a field (for reporting) on each work order that classifies leaks as follows:

   Class 1 – Leak should be repaired immediately. The leak has the characteristics of a large leak and could be undermining a road, or is likely losing a substantial amount of water

   Class 2 – This leak should be scheduled for repair as it has the characteristics of a large leak. It does not appear to be under a road, so this leak is not an emergency. Most leaks under road ways are class 2

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[3] At the economic level of water loss, the cost of additional water loss reduction outweighs the benefits.

Class 3 – This leak appears to be small and has very little chance of creating an emergency situation. These types of leaks are pinhole leaks on service lines that are not under a road, packing leaks, hydrant leaks, etc.

The current dual main replacement program will also reduce leakage as the old galvanized service lines in alleyways are known to be a major source of leakage.

6.1.2 District Zone Active Leak Detection

Hot-spot areas with unusually large leakage should be identified and measured through active surveys, and targeting methods such as DMAs. This would allow better targeting of resources to the most problematic areas. See Appendix I for additional details.

District metering may be complex or costly to implement in some portions of the system. Pilot study areas will allow these costs and complexities to be evaluated. Analysis of minimum night flows requires the use of sophisticated techniques to determine legitimate night use, which include conducting an Assessed Night Use study. Currently no DMA studies have been conducted within the Department service area.

6.1.3 Meter Accuracy

1. Conduct testing of a selection of retail meters of 1”, 1.5” and 2” sizes to complement the work on the 5/8” and 3” and larger meters that were performed in 2015. Continue to test meters of all sizes and manufacturers in the future. Record the average inaccuracy, weight the average depending on the volume through each meter size, and record in the audit for 2016
2. Continue to test the wholesale customer meters twice per year (as demand dictates). Determine if there are any inaccuracies and record this in the overall audit. Implement a process where any inaccuracies are actively recorded in such a way that reporting can occur for the annual audit. In addition, develop a written procedure that insures that all water used for testing is being accounted for in future audits. This information should be given to the Water Use Efficiency Manager on a monthly or quarterly basis
3. Analyze production meter testing results every year, and note and calculate any discrepancies on the audit.

6.1.4 Billing System Accuracy

1. Conduct detailed review of billing system operations, including but not limited to;
    a. Review of large meter multipliers
    b. Review of classifications for accounts with change of use
    c. Cross-reference property parcels, tax and utility records to water utility account records
2. Conduct pilot billing system anomaly assessment to make sure that there are no errors in accounting of data, or from meter readings to the billing system
3. Complete an inventory of all large meters and compare against the billing system. During the inventory, update all meter details, premise types, and proper installation. Identify meters that may be under or over-sized. When reviewing the billing and consumption data, develop a testing schedule ensuring that priority is given to testing meters with the highest return on investment.

Some of the business best practice changes which could be used to improve and reduce water losses are outlined in Sections 6.1.1 through 6.1.4.

6.1.5 Prioritization of Implementation Programs

Each of the programs described above and in the outlines below will provide guidance in reducing the volume of water loss and/or reduce the revenue impact of those losses. As expected, some will have a faster return on investment. As the analyses are developed and data further validated, the level to which losses can be reduced will be better understood. Leak repair prioritization should be considered as leak run times for high volume leakage should have a higher repair priority. As a start, leak classes should be added to the current leak work order generated by the pinpoint technicians. The analysis of existing leakage should be prioritized but development of the DMAs and pressure management pilots will enable more accurate cost benefit to be developed for real losses. This will help to determine whether techniques such as standard acoustic surveys, technology (e.g. noise loggers), or pressure management are the most effective for reducing leakage. Apparent losses are already being prioritized through the analysis of the meter testing data over the past few years which assists in determining when meters are failing and when they should be replaced. This prioritization will be improved as these dynamics are better understood through analysis of additional data and through evaluation of the billing system and its interaction with these metering systems. The efforts of the Department resulted in a slight reduction in the apparent loss component for the 2015 audit.

6.1.6 Validity of Data - Improving Validation

Improvements in validation could include annual review of data and more discussions regarding the scoring of the accuracy of data. The PIs developed should be used in this effort. This is also completed within the AWWA Free Water Audit Software on a basic level (using a 1 to 10 scoring system), and this format could be included in the additional PIs. Staff would then review the scoring and the importance of the variable and work towards improving the validation scores of the most important indicators.

Transparent analysis of data is being developed. A revenue enhancement team should be set up to include members from each department who make sure all the data is reviewed, and estimates are replaced by actual data through increased validation. Each member should be accountable for their portion of the data set which could then be divided among team members in a similar format with the PIs. This group should meet at least every quarter. The departments involved in this team should include (but not be limited to): Administration/Management, Customer Service/Billing, Finance, Meter Maintenance, Operations, Personnel/Human Resources, Special Projects, and Treatment. All data generated by this revenue enhancement team should be managed by one person since running data through one person on a regular basis will allow the water loss components to be better understood and performance and efficiency can be more closely monitored. Recommendations to increase data validation for future audits are as follows:

1. Conduct discussions with relevant staff for each of the inputs which have a validation score of 9 or less
2. Continue to evaluate calibration and testing data for production/finished water meters on an annual basis. Conduct flow volume to complement the electronic calibration. Move from

estimation to calculation of the master meter error adjustment (see meter accuracy section for retail meter data validity)

3. Continue to conduct the audit on an annual cycle. Continue discussions with the water loss working group (if assembled) to analyze and assess water losses and to create accountability for data

4. Increase the data management of the large customer meters and continually evaluate the test results. By analyzing and reporting the results, the Department can identify anomalies quickly thus reducing the apparent loss.

6.1.7 Continue Annual Water Audit

Continue to conduct an annual water audit for the entire Department's system, and if possible for selected pressure zones. In addition, future auditing and reporting for the Department should be performed with either an overreaching audit department/management analyst or a third party auditor. This party will review the documentation, and report it annually to all departments (at least internally).

The AWWA methodology removes itself from the unaccounted-for-water percentages used in previous years, and focuses more on performance indicators such as gallons per connection. These indicators are generally more robust and less susceptible to climatic changes from year to year. Percentage indicators are affected by the increased consumption common when the climate is hot and dry. It is expected that percentages will still be used by administration and budget staff, however, with respect to water losses; percentage is a poor indicator and should be used sparingly.

In 2016, a Water Use Efficiency Manager was assigned to collect, review and control the 2015 annual audit data. This step shows the commitment made by the Department and is the most efficient method of managing and collecting the necessary data to increase system efficiency.

6.1.8 Analysis of Flow and Pressure Data

Analysis of flow and pressure should be conducted in order to evaluate the greatest risk for leakage. In general, the higher the pressure, the greater the risk of leakage there is. It should be noted that a pressure feasibility study should be conducted prior to lowering pressure in any zone to insure proper pressure is maintained at critical points.

Figure 6-1 shows an example installation of a pressure logger on the outlet from a PRV.

Figure 6-1 Example Pressure Logger Installation

6.1.9 Improve Current Leak Location Practices

Decreasing leak awareness times can be accomplished by educating and engaging the public, utility staff, and private groups to be more vigilant in reporting leakage. This can be partially achieved through the existing Public Awareness Program. Leak location times can be reduced by utilizing specific technology and by providing additional training of leak-locating crews to classify leaks on work orders. Leak prioritization should be considered to reduce water loss and reduce emergency call-outs attributed to damage caused by large leaks. See Appendix I for additional leak detection details.

6.1.10 Meter Accuracy - Water Meter Testing and Replacement

Meter accuracy is one of the most important factors with respect to overall water losses in the Department system. Improvement in this area has significantly reduced the value of apparent loss from 2014 to 2015. The following subsections outline some of the methods which can be used to analyze the true value of the losses and ways to alleviate them.

6.1.11 Volume Limits

A sample of residential meters with throughput volumes which are above the warranty limits for repaired meters should be tested (Table 6-1). It is expected that there are a number of 2”, 1.5”, 1”, and $^5/_8$” meters with flow volumes in excess of the warranty limits. The 5/8” meters are already being tested as part of an ongoing program initiated in 2012.

Meter testing is expected to determine that degradation of the meter accuracy occurs at a rate of throughput greater than the warranty volume. This may be up to three times the warranty (as developed in previous studies), but only organized testing and analysis of these results will verify.

Table 6-1 Example Meter Volume Warranties

METER SIZE	UNITS	WARRANTY LIMITS	1.5 X WARRANTY
5/8-inch	CCF	2,005 (1.5MG)	3,008 (2.25 MG)
1-inch	CCF	4,010 (3MG)	6,015 (4.5 MG)
1.5-inch	CCF	6,684 (5MG)	10,026 (7.5 MG)
2-inch	CCF	10,694 (8MG)	16,041 (12 MG)

If the customer is using enough water for the meter to be out of warranty (through flow volume) within five years, then the customer should be contacted in an effort to reduce their usage to within the normal range of the meter warranty. If this is not possible, the meters should be changed out for meters with larger diameters (once meter-sizing analysis determines the best meter size for the customer [see AWWA manuals M22 and M6 for more information]). In addition, continued enhancements in meter accuracy will improve revenue recovery from sewer usage charges. These need to be reviewed within this strategy.

6.1.12 Age Limits

Most meter replacement programs are based on age. In many cases, the turnover of meters is quicker than necessary. The same standardized testing regime used for volume of throughput should be completed for meters with respect to age as well. Tests from other systems have determined replacement age up to 25 years (depending on other factors such as volume of throughput). This would be 10 years beyond the factory warranty limits, and could theoretically defer 40% of normal expenditure on the meters compared to a repair policy just based on warranty.

It should be noted that we are not recommending a blanket meter replacement program every 25 years. This is the expected average age of meters, due to programs and testing developed through careful study, and would need to be related to the Department specific data for it to apply to the Department as well. The structured approach evaluating volume, variations in high, intermediate, and low flow, as well as age and meter sizing is recommended.

6.1.13 Testing of Meters

The format of meter testing should follow the current AWWA standards. This is as follows:

Table 6-2 AWWA Standard Flow Test Ranges

METER SIZE	UNITS	FULL	INT	LOW
5/8-inch	GPM	15	2	¼
1-inch	GPM	40	4	¾
1.5-inch	GPM	50	8	1.5
2-inch	GPM	100	15	2
3-inch	GPM	150	20	4
4-inch	GPM	200	40	7
6-inch[4]	GPM	500	60	12

Additionally, each test should include a "test blank" which is a new meter with known test history from the manufacturer. If this meter when tested is more than 2% outside the manufacturer tested range, then the meter should be sent back to the manufacturer for re-testing. If there is still a 2% discrepancy between the manufacturer's test and the test conducted by Department staff, then another representative test should be conducted by a "third-party" meter tester. Once this is conducted the correct analysis can be evaluated.

6.1.14 Conduct Assessment of AMR/AMI Implementation

An evaluation of the costs and benefits of the current metering programs was underway in 2015. The review will include expected timelines and costs for future maintenance and/or replacement. Currently the staff costs for billing are very low, but additional factors would be required to make a fixed network or similar AMR/AMI implementation cost effective. Staff would assess and report on these costs and benefit, and recommend the most advantageous program.

6.1.15 Billing System Accuracy

The Department has dedicated staff and processes in place to assist in detecting billing system inaccuracies; however many of these checks and controls are dedicated to high or low exceptions, meter changes, sub meter usage, and no-reads with limited checks for reviewing system accuracy on other bills. It is recommended that the Water Use Efficiency Manager assemble a non-revenue water team that includes a person from the billing department that identifies additional anomalies on a monthly or quarterly basis.

6.1.16 Review Unauthorized Uses

Conduct an analysis of theft of service including customers not currently receiving a bill. This should be in conjunction with a billing analysis. Initial review would include analysis of customers with

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[4] The large meter testing flow rates are being changed in the newest version of AWWA Manual M6 (2014). See this manual for more detailed testing information.

water service but no wastewater service, accounts that consistently read zero, identification of addresses with no service, etc.

6.1.17 Evaluate Miss-classified Accounts

Evaluate and correct accounts with miss-classified meter types (residential or irrigation) to enable more equitable cost of service for all customers. The water use associated with a sprinkler account is not assessed a sewerage charge, therefore any miss-classified accounts would need to be determined and changed. As part of the large customer meter assessment, it was recommended that all large meter premise types be verified and corrected to help identify accounts where incorrect meter sizes may be inaccurately registering low flows (over-sized) or excessive wear may be occurring (under-sized).

6.1.18 Water Billing Data Quality Control

Although the Department has staff specifically dedicated to the billing process and read exception analyses, additional resources would be beneficial as existing staff have other billing related tasks. Under this strategy, the Department should consider hiring a full-time Management Analyst to oversee the water loss reduction and revenue enhancement program. Developments in water loss reduction must be documented to show that the Department is improving, and that the investment committed to the Billing, Meter Maintenance, and Leak Detection/Operations departments are reducing these losses. The Management Analyst should interface with all relevant departments, collate and organize all the data, and prepare reports on the performance of each area. This will include, but not be limited to, the following recommended activities:

1. Review sewer usage charges to improve revenue recovery from inaccurate meters. This is an add-on to the analysis of meter accuracy. Since it is not exactly a one-to-one relationship between the inaccuracy of the water meter and the loss of sewer charges, this needs to be analyzed separately
2. Review customer accounts with a water account but no wastewater account
3. Review fire line classification and determine if any are unbilled.

6.2 Economic Analysis of Losses

In the current economic climate, financial pressure will drive all investments in infrastructure which can drive down leakage and apparent losses. It will be a very important next step to continue to evaluate the economic level of each of the water loss areas.

Focusing on one or more of the best practice improvements depicted above can have the effect of driving the annual water loss volume from the current level towards the unavoidable annual volume level. During 2015, the Department took steps to reduce the cost of apparent loss. The Department should focus on achieving an economic level of water loss savings from recovered water equal to the expenditure. This is known as the economic level of loss. Keep in mind; all new sources have an associated development cost therefore the economic level of recovery for real losses should also account for the minimum amount that a new water resource can cost. Another factor to consider is the value of repairing a small leak that prevents a catastrophic event in the future. This avoided cost is a more relevant baseline for the Department due to the future water resource constraints suggested in the 20 year planning horizon of the Water Use Efficiency Plan.

Appendix A—Implementation Plan (Exhibits 17A & 17B)

Special Permit Condition No. 20 requires the Department to report on the status of activities presented in Exhibits 17A and 17B of the permit. The following is a list of activities with reference numbers as they are shown in the Exhibits - detail on each activity is provided in subsequent pages:

Appendix A – Table of Contents

Pilot AMR to Improve Data Handling and Reduce Cost

Characterize Residential Water Demand Use Pattern

Determine Economic Optimum for Residential Meter Replacement

5.3 Recommendations for Real Loss Reduction

5.3.1 – System Design

History

Refer to Introduction on page 1 for detail

Recommended Follow-up Activities

None

5.3.2 – System Management

5.3.2.3 – Asset Maintenance or Replacement

Action Item: The Department initiated efforts to evaluate and improve the distribution pipe replacements.

History

In 2010, the Department performed an "Economic Analyses of Leak Detection Program and Pipe Replacement" study, which evaluated historical trends to establish an adaptive strategy for pipe replacement and leak detection programs based on statistical analysis of leak incidences, pipe replacement investments, and economic levels of return. The study proposed a modified approach to align system investments with the economic impact of leak incidences.

In 2010, the Department also initiated the "Condition Assessment of Pre-stressed Concrete Cylinder Pipe (PCCP)" program which surveyed the major water transmission pipelines. As a result of the assessment, a rehabilitation program was developed using a Carbon Fiber Reinforced Plastic (CFRP) system. Over 40 miles of PCCP were inspected in 2011 and 2012 the Department completed inspection of 120 miles of large diameter PCCP pipe in the water distribution system and successfully repaired and/or replaced 118 segments. In 2013 the Department updated the distribution system data base with new developments and replacements including information on pipe age and pipe material to better correlate pipe breaks with pipe rehabilitation and/or replacement efforts. In 2014 the Department updated the GIS data base for replacements including information on pipe age and material.

Completed in Audit Year 2015

In 2015 the Department continued to update the GIS database. Approximately 88 miles of distribution water lines were added during the year.

Recommended Follow-up Activities

- Connect leak detection and leak repair program to the GIS database. Include all leak data as well as a complete failure analysis documented during repairs
- While collecting leak detection and pipeline data, record the information that integrates the interconnectivity of the system and the relation to other sets of data, such as underground pipe material, size, age, and environment (i.e. soil type, soil corrosivity, etc.) that can help document the basis for pipe failure
- Validate the accuracy of the asset condition assessment by evaluating through field testing
- Follow up on the recommendations of this study in order to conduct pipeline condition assessment on those segments of the distribution system found critical.

5.3.2.4 – Reduce Maintenance Response Times

The Department should consider implementing protocols to reduce the time it takes for maintenance crews to respond to leaks and to improve the speed and quality of its repairs.

History

Basic data on speed and quality of repair has been maintained for many years; however, it has not been transferred to Asset Management databases for more accurate review. Quality of repairs has been driven by utilization of standard methods and practices such as those developed from AWWA Standards documents. In 2013 the Department commenced incorporating leak detection data into the Enterprise Asset Management System (EAMS) to keep track of leak response time and inventory repairs (i.e. new and re-patches). To identify leak run times, data management personnel must now compare the leak pinpointing work order (access database) with the EAMS database repair work order. In 2014 the Department reviewed the tracking of leak response time and inventory repairs (i.e. new and re-patches). Example component analysis review of response times was considered.

Completed in Audit Year 2015

The Department has added additional staffing which assists in maintaining the 10 month survey pace even with the new logger deployment standards that require the distance between loggers be shortened to enable the detection of quiet leaks. This spacing was determined by completing a pilot study that included a manual point to point survey compared to a logger survey. The closer logger intervals resulted in an increase of "BG – Breaking Ground" or visible leaks and "NBG – Non-Breaking Ground" not visible. See Appendix E for a list of leaks documented during 2015: 1,491 leaks of the 3,041 reported were a result of the leak detection program's active survey.

Recommended Follow-up Activities

- Continue with development of an active database recording time that leaks were reported, pinpointed and repaired. The costs of repair (labor and materials) should also be included and the amount of lost water estimated when this data is available. This data should be used to determine the costs of each leak and a cost-benefit analysis of avoiding them

- To reduce response times to repair leaks of the greatest value, it is recommended that the program include leak classifications as part of the work order generation procedures as a means to prioritize leak repairs
- Evaluate awareness times in cases where known leaks have run for extended periods of time but were not associated to leakage until after a leak was found. If possible, attempt to review the current leak back-log and select leakage that have the greatest potential for loss. For example, a leak on a 6" cast iron line that could be correlated from multiple access points is likely leaking more severely than a main line leak on a 2" steel line. Without hearing the sound, this will not always be the case, but most main line leaks should have a higher priority for repair
- Conduct a review of the quality of fittings and repairs. Evaluate if any of the fittings used are performing poorly and if so review the standards and specifications around these items
- Review current failure analysis documentation as well as all repair data to determine a more cost efficient procedure to increase return on investment while reducing water loss. This process is made much easier if all data were managed through the Departments GIS database system. The Department should consider merging all data to one location that is managed by their GIS software.

5.3.2.5 – Active Leakage Control and Sounding

The Department continued their active leakage control and sounding program. The Department is now employing a more strategic strategy to insure thorough coverage. For example, all surveys are not completed by lift and shift logger techniques. In the downtown area where traffic is heavy and surveying is dangerous, the quality of survey is compromised due to extraneous noise and service draw. In this location, the Department has installed permanent loggers connected to a fixed network which allows surveys to be completed remotely and more frequently.

History

In 2013 the Department initiated an evaluation of automated leakage detection through leak noise loggers. Two systems were tested and completed and review of results is underway. The Department has also increased the sensitivity of its leak detection program by reducing the distance between noise loggers (both automated and manually deployed). In 2014 the Department focused on improving efficiency of the leak noise logger deployments. The lift-and-shift methodology was used to survey the entire system and allow more effective use of leak pinpointing resources.

Completed in Audit Year 2015

The Department is in the process of incorporating leak detection data into the Enterprise Asset Management System (EAMS) to keep track of leak response time and inventory repairs (i.e. new and re-patches). Additionally, the Department increased the number of personnel in the leak detection program and purchased additional loggers. The department analyzes sound from 360 access points each day which has resulted in an increase of leaks identified. This increase has caused a back-log as the repair crews prioritize repairing visible (reported) leaks.

Recommended Follow-up Activities

- Consider modifying the way the leak data is managed to make tracking leak run times and reporting easier to manage. Once the information is set up for analysis, consider expanding newly employed strategic survey strategy
- Continue to evaluate leaks per mile of main for the total system and per sector to gain information on where real losses are. Consider connecting with the hydraulic model to determine if pressure, age, or material has an effect with respect to leakage.

5.3.2.7 – Pressure Management

History

The Department is in the process of developing a pilot study for Pressure and Zone Management that will assess a strategy for timely reducing system-wide real water losses (and attendant non-revenue water) without compromising level of service. In 2013 initial review of the Miami-Dade system was conducted and the Miami Springs area was chosen to be evaluated for a pilot zone evaluation for pressure management. In 2014 additional review of the Miami-Dade system was conducted and metering data was evaluated prior to any final decision for a pilot zone evaluation for pressure management. The leak detection personnel stated that the pressure is too low to employ pressure management.

Completed in Audit Year 2015

There is no plan to conduct pressure management at this time. Because the average pressure throughout the system is approximately 55 GPM, it is believed that the critical points will not allow for substantive pressure reduction.

Recommended Follow-up Activities

- Complete pressure feasibility studies in any pressure zone considered for pressure management. Include pressure logging at all critical and high points in each zone.
- Assess the effectiveness of pressure management after the pressure feasibility study is completed.

5.3.2.8—Speed and Quality of Repairs

Due to the increase in leakage realized in 2015, leak back logs have increased. Currently there is no prioritization of leak repairs. Department personnel feel that the leak backlog issue could be solved if the leak detection program has one or two repair crews assigned specifically to the leak detection program.

History

In 2013 the Department was in the process of incorporating leak detection data into the Enterprise Asset Management System (EAMS) to keep track of leak response time and inventory repairs (i.e. new and re-patches). In 2014 the Department continued to incorporate leak detection data into the Enterprise Asset Management System (EAMS) to keep track of leak response time and inventory repairs.

Completed in Audit Year 2015

In 2015, the Department continues to be able to review leak run times, but it requires comparing the EAMS database with the Access Database used for creating repair work orders. It is recommended that the data management is stream lined to allow for an in-depth analysis of the distribution system. This analysis will likely identify a more strategic approach to leak detection that will reduce real losses more efficiently.

Recommended Follow-up Activities

- Update the distribution system data base with pipe age and pipe material to better correlate pipe breaks with pipe rehabilitation/replacement efforts.
- Create and monitor metrics for quality of fixtures (how often they break, etc.) and the time from awareness to repair.
- Include in the EAMS tracking a detailed failure analysis as well as whether a leak was reported or unreported. This step will help management make more informed decisions regarding line refurbish/replacement or the possibility of implementing a strategic survey to increase efficiency.

The following activities impact the Apparent Loss component of the water audit. These components are listed under the Real Loss Reduction section of Exhibit 17A.

Perform Venturi Comparative Tests - WTPs

The Department is currently performing comparative accuracy testing on the combined raw and finished water meters at its water treatment plants.

History

In 2012 the Department:

- Contracted with GE Measurement and Control to conduct flow diagnostics of all the magnetic flow meters currently installed at the supply wells in the system. The test results were presented in the June 3, 2012 report titled “Well Water Flow Meter Verification Report” and showed that all meters are within the manufacturer’s normal operating range and are registering flows accurately
- In 2012 the Department also conducted their biannual calibration of the flow transmitters at all raw and finished water venturi meters in the three plants. Calibration reports indicated that all transmitters “passed” the calibration tests in both the “as found” and “as left” condition
- In 2013 calibration was conducted at the Alexander Orr, Hialeah and Preston Plants for four raw water Venturi Meters and finished water meters. GE Measurement and Control was again contracted to conduct flow diagnostics of all the magnetic flow meters currently installed at all the supply wells in the system
- In 2014 a Production Meters Assessment was initiated to more accurately validate the finished water venturi metering systems.

Completed in Audit Year 2015

This year, the Production Meters Assessment was implemented to more accurately validate the finished water venturi metering systems; the assessment was completed in 2015.

Recommended Follow-up Activities

- Continue to flow test and calibrate meters on an annual basis by:
  - Testing for the raw and finished Venturi water meters at some of the Preston and Hialeah plants cannot be performed until test taps are installed. Review installation locations for test taps needed to validate the level of metering accuracy at the Preston/Hialeah plants
- Identify any capital projects that may be required to support meter testing.

Perform VENTURI Comparative Tests – Wholesale Customers

The Department continues to perform comparative accuracy testing on its wholesale customer venture and turbine meters. They do not test 2” bypass meters.

History

Venturi Meter Sites: In 2010, steps were taken to connect these meters to SCADA. Test tap installations required for accuracy testing are pending;

Turbine Meter Sites: In 2010, these meters were connected to the AMR system. Evaluation of other wholesale meters is pending upon installation of additional test taps;

Wholesale customer meters were flow tested annually where possible;

In 2013 and 2014, the testing goal for wholesale meters was semi-annual.

Completed in Audit Year 2015

The goal for testing wholesale customer meters remains semi-annual.

Recommended Follow-up Activities

- Continue to plan Capital Improvement Programs required for testing, monitoring and/or replacement of inaccessible meters
- Additional evaluation of the SCADA or AMI connectivity is being considered
- Test by-pass meters when possible
- Conduct a wholesale customer unmetered connection survey
- Meters with high consumption should be considered for additional testing to insure optimal efficiency.

Conduct wholesale customer unmetered connection survey [Completed]

PILOT Fixed Network AMR

The Department has implemented two fixed networks to monitor for leakage in hazardous areas. They are currently evaluating the use of a mobile cellular platform for areas where they are unable to use line of site technology. It is recommended that lift and shift and permanent installation loggers are managed through GIS.

Fixed Network Installation

History

The Department has tested AMR (automatic meter reading) which collects meter data and transfers the information to the utility, and AMI (advanced metering infrastructure), also known as smart meters which collects and stores data and allows for two way communication. In 2010, the Department initiated the expansion of the AMI network with the installation of additional AMI meters from Sensus Metering Systems, Inc. A total of 5,120 AMI & AMR meters were installed in the service area with 4,300 AMR meters installed specifically in the Miami Springs area and 820 AMI meters installed in other locations. A joint AMI project was also created with the Miami Dade County Parks and Open Space Department. Additional AMI and AMR interface units were connected to the system in 2013 and the Miami Springs network was tested. This system was operational in 2013, 2014 and 2015.

Because of the AMI meters in the Miami Springs area, a pilot study using permanently installed AMR leak loggers was completed. This allowed the Department to test the radio loggers, complete multiple surveys, and compare the logger effectiveness against a point to point survey. The results of the pilot were such that the AMR loggers were moved to strategic locations where manual surveys are difficult to complete due to limited accessibility and heavy traffic.

Completed in Audit Year 2015

Data from the system had been reviewed and evaluated and an AMI assessment was completed. The Department is currently considering AMI and will likely put out an RFP during 2016 to expand throughout its service area.

The pilot fixed network conducted for the leak loggers was completed. It was determined that fixed networks would be used for logging in areas where lift and shift or manual surveys are not practical.

Recommended Follow-up Activities

Continue to expand AMR/AMI network and continue to test its effectiveness in the Department service area. Evaluate total system AMR/AMI potential as well as the strategic use of AMR leak logging.

Enhance GIS Database

The Department is currently enhancing its GIS database.

History

The Department continues to enhance its GIS database to include more information on its distribution system features (pipe lengths, diameters, materials, age in service, etc.).

The GIS database was queried to access the current mileage of pipeline within the system. The database continues to be updated actively whenever new water main projects are completed and after any field-based reports show differences from what is currently within the database.

Additional improvements in the GIS database were included in 2014. This included removal of a small number of miles of raw water main previously included in the audit.

Completed in Audit Year 2015

Additional improvements were made to the GIS database. Miles were added to the database during the year.

Recommended Follow-up Activities

Plan integrated use of expanded capabilities in asset management program and conduct initial field validation to prove accuracy of database. Incorporate leak detection survey, pinpointing and repair activities into the GIS database. Design quick reports for all leak detection details including a comprehensive failure analysis conducted during repairs.

The numbers for the following section were derived from Exhibit 17B of the water use permit.

6.3 Recommendations for Apparent Loss Reduction

6.3.1 – Reducing Unmetered Supplies

The Department continues with efforts to reduce unmetered water supplies. It is recommended that a Water Loss Manager position be created to lead a water loss team which could more accurately identify and quantify unmetered supplies.

History

Fire-fighting and main flushing are the largest unmetered uses in the Department's system. Although not metered, main flushing volumes are estimated using industry accepted (flow x duration) protocol and are consistently recorded. Usage by fire departments is currently neither estimated nor recorded. In 2010, Fire Departments that receive water from the Department were identified and contacted to request their cooperation in developing a methodology to better account for their water usage. In 2013 main flushing continued to be monitored actively and flow x duration calculations developed. In 2014 main flushing continued to be monitored and flow x duration calculations developed. Fire department water use continues not to be accounted for as was the case in previous years.

Completed in Audit Year 2015

Main flushing continued to be monitored and flow x duration calculations developed. Fire Departments in Coral Gables, the city of Miami, and Miami-Dade County supplied estimates of use on a monthly basis. Included in the internal non-revenue quarterly report, were estimates for inspections, distributions, automatic devices, and the hydrant section. It appears that Vactor truck usage is also accounted for, but this value appears to be inconsistently recorded. Also included on the quarterly NRW report is the estimated water recovery (based on calculations upon visual inspection). Each leak is estimated to be leaking for 180 days unless the leak is caused by a contractor mishap.

Recommended Follow-up Activities

- Continue to conduct meetings with all Fire Departments to evaluate their water usage
- Based on the feedback from the Fire Departments, develop a methodology for appropriately accounting for Fire Department water use
- Record all unmetered uses and develop annual trends of this usage. As part of the NRW team, the volume of water used to test meters should be tracked and added to the unbilled metered component

6.3.2 – Improved Meter Accuracy

The Department continues to conduct field accuracy testing of commercial meters to improve their meter accuracy.

History

Some commercial meter sites have proved to be challenging to test, not because of the sites, but because of circumstances such as Jackson Hospital's inability to shut down an entire line for testing purposes.

In 2010, a dedicated testing site was installed to test 4" meters. In 2012 a residential meter testing program was initiated. More than 800 meters were tested in 2012. In 2013 the Department continued to conduct accuracy testing and evaluation to estimate the overall accuracy and replacement of suspect retail meters. Analysis of test data was also conducted by staff interns to evaluate age-based performance data. New meters such as Sensus iPerl were trialed. In 2014, the Department focused on large customer meter testing and repair. The duration between tests was actively reduced in this audit year. The Department implemented a large customer meter assessment (2014/2015) to help identify meter anomalies and determine proper size and type of meters installed on customers with 3" and larger meters. During 2014, 332 tests were completed on meters 3" and larger.

Completed in Audit Year 2015

In 2015, the Department completed the large meter assessment project and increased the number of large meters tested (from 332 in 2014 to 690 in 2015). Additionally, the department evaluated the testing protocols of each meter test vehicle to insure that the methods used were consistent between all technicians. Several large meters were repaired or replaced during the 4th quarter of 2015 which slightly reduced the cost of apparent loss. The Department tested 1,241 5/8" meter during 2015. The low flow accuracy rate averaged approximately 92%.

Recommended Follow-up Activities

- Determine meter testing frequency by meter size and configuration based on economical and statistical analyses of commercial meter samples; increase tests on high consumption and problematic meters; base test frequency on economic impact
- Install test taps at locations that have been evaluated and inspected where displacement and turbine meters were being used in a compound setting
- Install and test new meters for better accuracy and less maintenance
- Monitor and analyze data to direct replacement and maintenance improvements
- Bench test or have 3rd party contractor complete tests on meters where high flow test requirements are not being met (high volume customers)
- Test all by-pass meters regardless of size
- Complete demand profiling on meters that appear too large or too small for the consumption that is being registered

6.3.3 – Commercial Meter Types and Sizes

6.3.3.2.1 – Compound Meter Usage Compared to Same Size Turbine Meters

The Department initiated efforts to compare compound meter usage to similarly-sized turbine meter settings. Most meter change-outs have been to "Omni" meters to register low flows instead of compound meters.

History

The Department obtained a few new style “Omni” meters from Sensus for evaluation. These meters act as compound meters and were installed by the Department at various sites and passed the evaluation process with satisfactory results regarding measurement of ultra-low flows with a full range of high flows. The “Omni” meters have now become standard for the Department. In 2013 the Department continued to use and specify the Omni meters. Continued analysis has been conducted to prove out the satisfactory results developed in previous years. In 2014 the Department continued to use and specify the Omni meters. Continued analysis has been conducted to prove out the satisfactory results developed in previous years.

Completed in Audit Year 2015

The Department continues to use and specify Omni meters for all replacements. Continued analysis has been conducted to prove out the satisfactory results developed in previous years. An evaluation of the meter test data revealed that several Omni meter tests resulted in an uncharacteristic slight over-registration. It is possible that this result could be due to test procedures.

Recommended Follow-up Activities

- Continue to document the “Omni” meter test results (look for slight over-registration). Insure that consistent testing protocols are used by all meter technicians.
- Develop and analyze a database with testing data results. As part of the large customer meter assessment program, it was recommended that an inventory and premise type evaluation take place to insure the inventory accuracy. This step will assist in the identification of possible incorrect sizes or types of meters
- Continue replacing the obsolete turbine meters with “Omni” or other reliable meters currently under evaluation by the Department
- Continue to test the turbine meters to determine the meter accuracy and to rank replacements or test frequency based on consumption and economics.

6.3.3.3 – Looking Forward (Setting Economic Meter Testing Goal)

History

The Department tests all wholesale meters twice per year and all large customer meters annually.

Recommended Follow-up Activities

It is recommended that meters with the highest financial impact are considered for more frequent testing than meters with minimal financial impact. This method may result in specific meters being tested more than twice per year, while meters with limited demand are tested less frequently.

6.3.4 – Improved Calibration of Wholesale Customer Meters

The Department is currently performing comparative accuracy testing on its wholesale customer venturi and turbine meters. Two inch bypass meters (SR and Omni) are not being field tested.

History

The Department performs testing of the wholesale turbine meters twice a year

Venturi Meter Sites: In 2010, steps were taken to connect these meters to SCADA. Test tap installations that are required for accuracy testing are pending;

Turbine Meter Sites: These meters were all connected to the AMR system;

In 2014, wholesale meters were tested at least one time.

Completed in Audit Year 2015

The current goal of the Department is to test all active wholesale meters twice per year. Wholesale meter tests are generally conducted by the lead meter technician and assisted by the technician assigned to the area where the wholesale meter exists.

Recommended Follow-up Activities

- Plan Capital Improvement Program required for testing inaccessible meters
- Continue to conduct semi-annual testing of active wholesale meters. It is recommended that large wholesale customer's meters are considered for increased field or bench testing if the consumption dictates
- It is recommended that by-pass meters are tested regardless of size. This is a good practice as low flows are prevalent on several wholesale meters.

6.3.5 – Wholesale Customer Unmetered Connection Analysis

The Department initiated unmetered wholesale customer connection survey and analysis.

History

In 2009, the Department found a wholesale meter by-pass that was opened allowing unmetered water delivery to the customer. All by-pass meters have now been locked and evaluation of metering or connection to SCADA will be undertaken in 2011. In 2013 the Department continued to check the by-pass meters to make sure they continue to be locked and no tampering had been conducted. In 2014 the Department continued to check the by-pass meters to make sure they are locked and no tampering had been conducted.

Completed in Audit Year 2015

The Department continued to check the by-pass meters to make sure they continue to be locked and no tampering had been conducted. This procedure occurs during the wholesale meter field testing process.

Recommended Follow-up Activities

- Complete the evaluation of metering and connection to SCADA of all the wholesale meters

- Continue to monitor all bypasses to make sure that no unmetered wholesale use is occurring. Testing all bypass meters is recommended as several wholesale customers have periods of low flow
- Install and test bypass meters on any unmetered line.

Conduct field accuracy testing of commercial meters

As documented in 6.3.2 of this document, the Department continues to employ an active large meter field test program. During 2015, the Department completed a large meter assessment that helped identify anomalies and protocol discrepancies. The goal for commercial meters continues to call for annual testing, with additional tests conducted on problematic, old, or high volume meters.

Pilot AMR to improve data handling and reduce labor costs

As mentioned previously, the Department has implemented two AMR pilots. All large customer meters are installed with ICE registers and can be read remotely. The Department is able to look at consumptions at 10 minute intervals if needed.

Characterize residential water demand pattern

The Department owns 12 MeterMaster flow recording devices. When a billing question arises, office personnel will program a recorder in the office. The programmed recorder is then given to a meter technician for installation. The recorder will monitor and record actual flow for several days to determine if the meter is working properly and is the correct type and size for the application. The Department has the equipment and ability to complete a demand profile exercise on a representative number of residential meters.

Determine economic optimum for residential meter replacement

This item requires that the Department characterize residential water demand patterns and determine economic optimum for residential meter replacement.

History

“MeterMaster” loggers were deployed in October 2008 to characterize residential demand and were rotated through a representative set of meters on a weekly basis. Residential demand data, along with age and meter testing data, was used to establish an economic optimum for meter replacement.

The Sensus SR model meter is an old meter design that comprises most of the Department’s meter inventory. In 2010, the Department investigated different meter models and began to consider new meters such as Sensus “iPERL” and in 2011, the Department installed over 4,000 of these meters. In 2012 a residential meter testing program was initiated with more than 800 meters being tested during that year. Review of the meter shop operations and practices was also conducted to improve efficiency of replacement understanding and procedures.

Retail customer meters were evaluated for degradation in 2013 to initiate more active replacement policies within the Department’s system. Review of the lead-free requirements of Section 1417 of the Safe Drinking Water Act were conducted to assess how it may affect the repair and replacement of the existing meter stock.

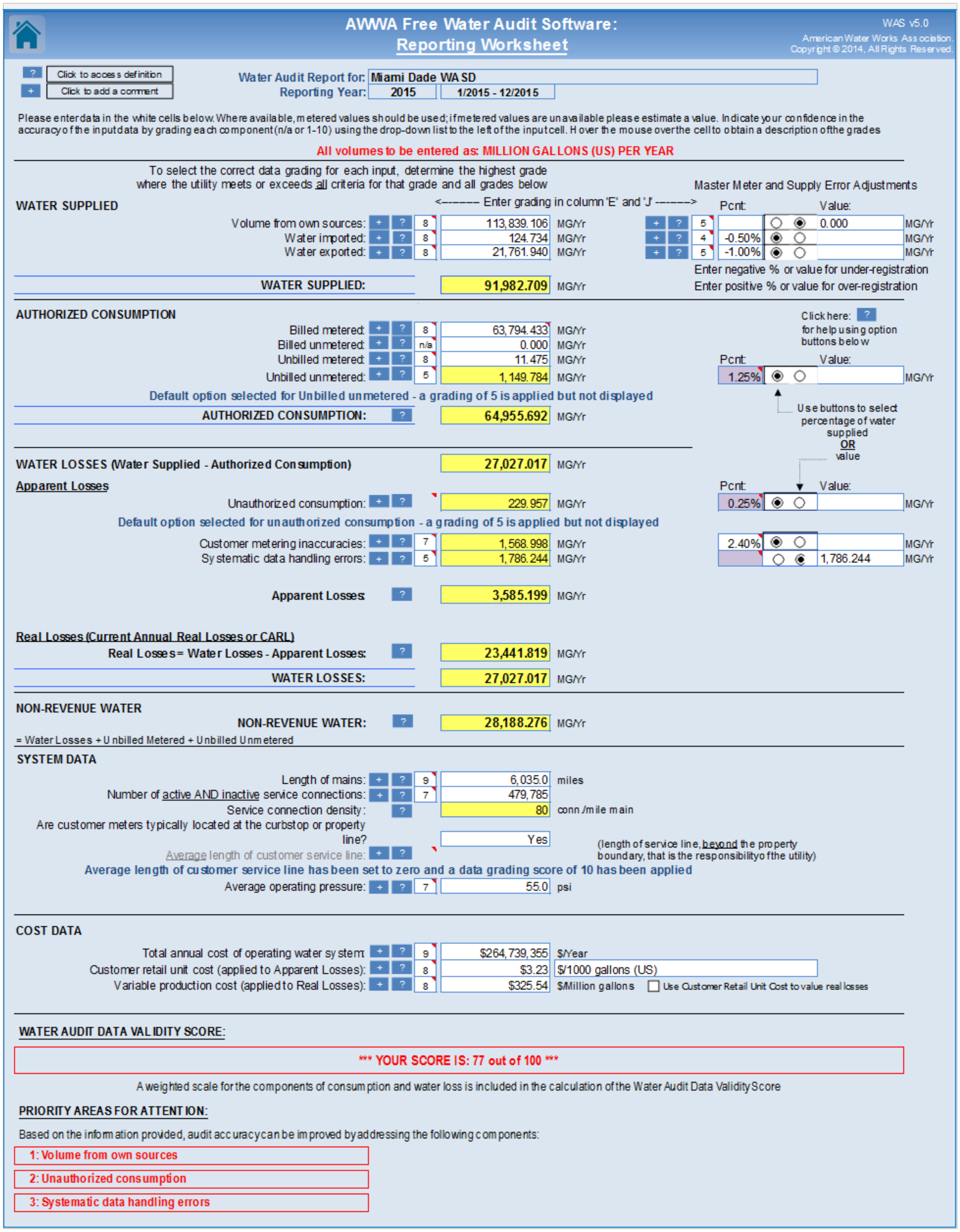
Completed in Audit Year 2015

Metering focus was shifted temporarily to the large customer meters in 2015. Approximately 1,241 5/8” meters were tested during 2015 with low flow tests (5/8”) resulted in an average of 92% accuracy.

Recommended Follow-up Activities

- Review residential testing requirements to improve small meter accuracy
- Continue logging and analyzing data from new-model meters installed in the system to update the assessment of the economic optimum replacement
- Continue the replacement of residential meters with the new “iPERL” or similar meters with integral data logging
- Conduct residential demand pattern analysis with new standard meters which can better measure low flows

Appendix B—Water Audit Report & KPI's



AWWA Free Water Audit Software: Reporting Worksheet

WAS v5.0
American Water Works Association.
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? Click to access definition
\+ Click to add a comment

Water Audit Report for: Miami Dade WASD
Reporting Year: 2015 | 1/2015 - 12/2015

Please enter data in the white cells below. Where available, metered values should be used; if metered values are unavailable please estimate a value. Indicate your confidence in the accuracy of the input data by grading each component (n/a or 1-10) using the drop-down list to the left of the input cell. Hover the mouse over the cell to obtain a description of the grades

All volumes to be entered as: MILLION GALLONS (US) PER YEAR

To select the correct data grading for each input, determine the highest grade where the utility meets or exceeds all criteria for that grade and all grades below

<------- Enter grading in column 'E' and 'J' ------->

WATER SUPPLIED

	Grade			Master Meter and Supply Error Adjustments: Grade	Pcnt:		Value:	
Volume from own sources:	8	113,839.106	MG/Yr	5		○ ●	0.000	MG/Yr
Water imported:	8	124.734	MG/Yr	4	-0.50%	● ○		MG/Yr
Water exported:	8	21,761.940	MG/Yr	5	-1.00%	● ○		MG/Yr

Enter negative % or value for under-registration
Enter positive % or value for over-registration

WATER SUPPLIED: 91,982.709 MG/Yr

AUTHORIZED CONSUMPTION

Click here: ? for help using option buttons below

	Grade			Pcnt:		Value:	
Billed metered:	8	63,794.433	MG/Yr				
Billed unmetered:	n/a	0.000	MG/Yr				
Unbilled metered:	8	11.475	MG/Yr				
Unbilled unmetered:	5	1,149.784	MG/Yr	1.25%	● ○		MG/Yr

Default option selected for Unbilled unmetered - a grading of 5 is applied but not displayed

Use buttons to select percentage of water supplied OR value

AUTHORIZED CONSUMPTION: 64,955.692 MG/Yr

WATER LOSSES (Water Supplied - Authorized Consumption)

27,027.017 MG/Yr

Apparent Losses

	Grade			Pcnt:		Value:	
Unauthorized consumption:		229.957	MG/Yr	0.25%	● ○		MG/Yr

Default option selected for unauthorized consumption - a grading of 5 is applied but not displayed

	Grade			Pcnt:		Value:	
Customer metering inaccuracies:	7	1,568.998	MG/Yr	2.40%	● ○		MG/Yr
Systematic data handling errors:	5	1,786.244	MG/Yr		○ ●	1,786.244	MG/Yr

Apparent Losses: 3,585.199 MG/Yr

Real Losses (Current Annual Real Losses or CARL)

Real Losses = Water Losses - Apparent Losses: 23,441.819 MG/Yr

WATER LOSSES: 27,027.017 MG/Yr

NON-REVENUE WATER

NON-REVENUE WATER: 28,188.276 MG/Yr

= Water Losses + Unbilled Metered + Unbilled Unmetered

SYSTEM DATA

	Grade		
Length of mains:	9	6,035.0	miles
Number of active AND inactive service connections:	7	479,785	
Service connection density:		80	conn./mile main
Are customer meters typically located at the curbstop or property line?		Yes	(length of service line, beyond the property boundary, that is the responsibility of the utility)
Average length of customer service line:			
Average operating pressure:	7	55.0	psi

Average length of customer service line has been set to zero and a data grading score of 10 has been applied

COST DATA

	Grade		
Total annual cost of operating water system:	9	$264,739,355	$/Year
Customer retail unit cost (applied to Apparent Losses):	8	$3.23	$/1000 gallons (US)
Variable production cost (applied to Real Losses):	8	$325.54	$/Million gallons ☐ Use Customer Retail Unit Cost to value real losses

WATER AUDIT DATA VALIDITY SCORE:

*** YOUR SCORE IS: 77 out of 100 ***

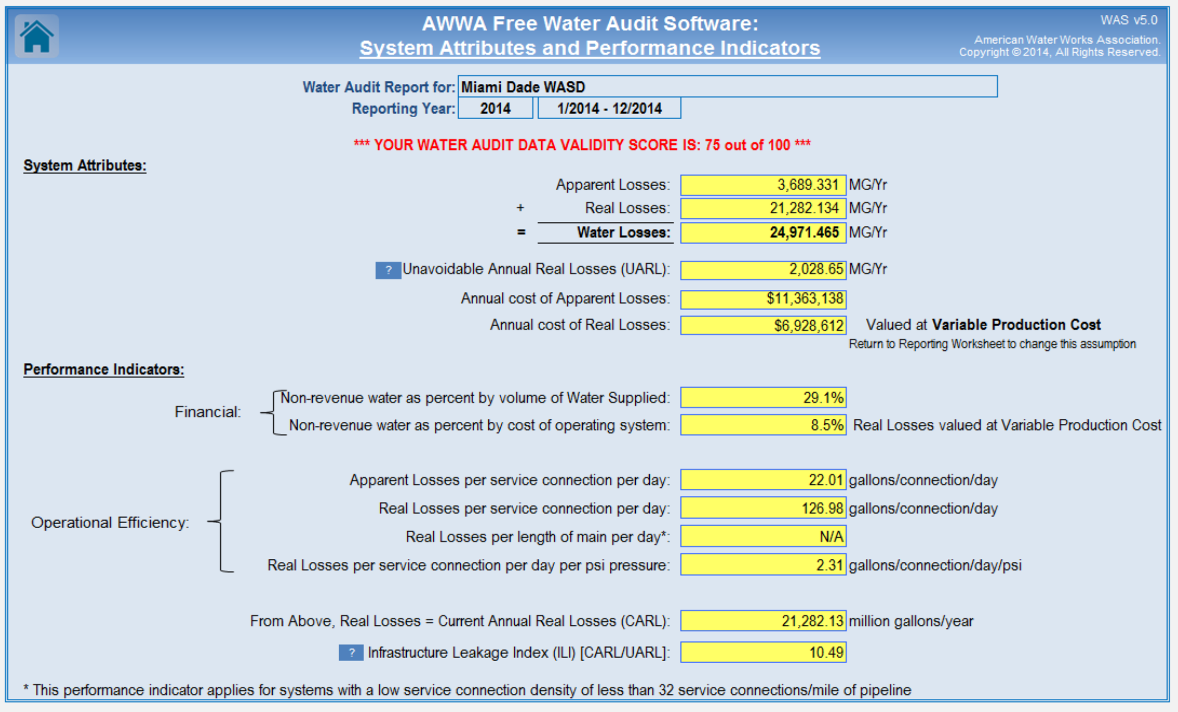
A weighted scale for the components of consumption and water loss is included in the calculation of the Water Audit Data Validity Score

PRIORITY AREAS FOR ATTENTION:

Based on the information provided, audit accuracy can be improved by addressing the following components:

1: Volume from own sources
2: Unauthorized consumption
3: Systematic data handling errors

2014 Performance Indicators



AWWA Free Water Audit Software:
System Attributes and Performance Indicators

WAS v5.0
American Water Works Association.
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Water Audit Report for: Miami Dade WASD
Reporting Year: 2014 | 1/2014 - 12/2014

*** YOUR WATER AUDIT DATA VALIDITY SCORE IS: 75 out of 100 ***

System Attributes:

Apparent Losses: 3,689.331 MG/Yr
+ Real Losses: 21,282.134 MG/Yr
= **Water Losses: 24,971.465** MG/Yr

? Unavoidable Annual Real Losses (UARL): 2,028.65 MG/Yr

Annual cost of Apparent Losses: $11,363,138
Annual cost of Real Losses: $6,928,612 Valued at **Variable Production Cost**
Return to Reporting Worksheet to change this assumption

Performance Indicators:

Financial:
Non-revenue water as percent by volume of Water Supplied: 29.1%
Non-revenue water as percent by cost of operating system: 8.5% Real Losses valued at Variable Production Cost

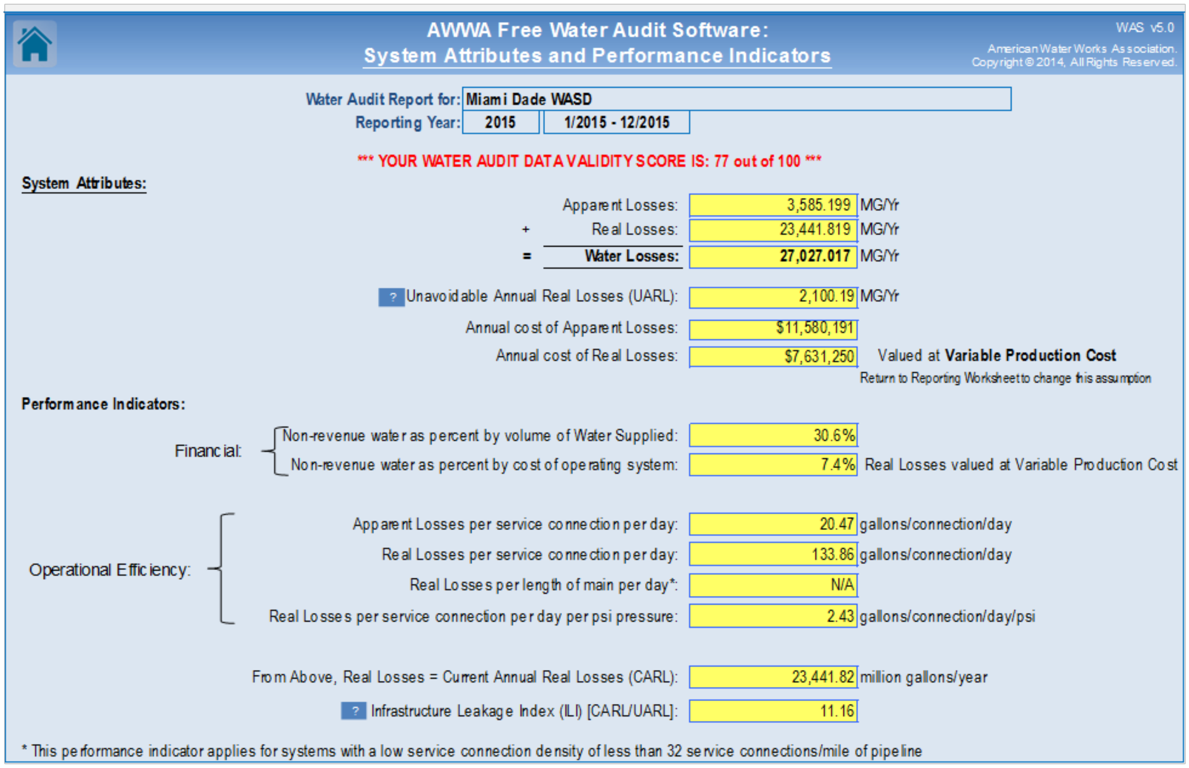
Operational Efficiency:
Apparent Losses per service connection per day: 22.01 gallons/connection/day
Real Losses per service connection per day: 126.98 gallons/connection/day
Real Losses per length of main per day*: N/A
Real Losses per service connection per day per psi pressure: 2.31 gallons/connection/day/psi

From Above, Real Losses = Current Annual Real Losses (CARL): 21,282.13 million gallons/year

? Infrastructure Leakage Index (ILI) [CARL/UARL]: 10.49

* This performance indicator applies for systems with a low service connection density of less than 32 service connections/mile of pipeline

2015 Performance Indicators



AWWA Free Water Audit Software:
System Attributes and Performance Indicators

WAS v5.0
American Water Works Association.
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Water Audit Report for: Miami Dade WASD
Reporting Year: 2015 | 1/2015 - 12/2015

*** YOUR WATER AUDIT DATA VALIDITY SCORE IS: 77 out of 100 ***

System Attributes:

Apparent Losses: 3,585.199 MG/Yr
+ Real Losses: 23,441.819 MG/Yr
= **Water Losses: 27,027.017** MG/Yr

? Unavoidable Annual Real Losses (UARL): 2,100.19 MG/Yr

Annual cost of Apparent Losses: $11,580,191
Annual cost of Real Losses: $7,631,250 Valued at **Variable Production Cost**
Return to Reporting Worksheet to change this assumption

Performance Indicators:

Financial:
Non-revenue water as percent by volume of Water Supplied: 30.6%
Non-revenue water as percent by cost of operating system: 7.4% Real Losses valued at Variable Production Cost

Operational Efficiency:
Apparent Losses per service connection per day: 20.47 gallons/connection/day
Real Losses per service connection per day: 133.86 gallons/connection/day
Real Losses per length of main per day*: N/A
Real Losses per service connection per day per psi pressure: 2.43 gallons/connection/day/psi

From Above, Real Losses = Current Annual Real Losses (CARL): 23,441.82 million gallons/year

? Infrastructure Leakage Index (ILI) [CARL/UARL]: 11.16

* This performance indicator applies for systems with a low service connection density of less than 32 service connections/mile of pipeline

Appendix C - Variable Production Costs

Water Source of Supply

ACCOUNT	ACCOUNT NAME	2014	2015
722010	Electrical Services	1,477,684	1,421,171
722020	Natural Gas	23,714	37,444
722110	Water & Sewer Service	35,960	36,055
722114	Purchased Water	460,338	309,322
722115	Prchsd Water-City of Homestead	41,901	46,853
722118	Calcium Carbonate Disposal	1,726,892	0
722130	Swm Charges Waste Disposal	0	0
726060	Fm Lt Eq Fuel	294,273	190,911
726131	It 800 Mhz Maintenance	191,223	55,211
Total	***Water Source of Supply***	***4,251,986***	***2,096,967***

Water Pumping

ACCOUNT	ACCOUNT NAME	2014	2015
722010	Electrical Services	1,222,135	1,212,814
722020	Natural Gas	5,292	2,706
722110	Water & Sewer Service	25	24
726131	It 800 Mhz Maintenance	191,223	55,211
741020	Compressed Natural Gas (Cng)	0	
Total	***Water Pumping***	***1,418,675***	***1,270,755***

Water Treatment and Purification

ACCOUNT	ACCOUNT NAME	2014	2015
722010	Electrical Services	6,720,310	6,309,178
722020	Natural Gas	3,319,933	1,538,231
722110	Water & Sewer Service	0	0
722118	Calcium Carbonate Disposal	928,697	4,694,216
722123	Hazardous Waste Disposal	24,302	31,224
722130	Swm Charges Waste Disposal	10,851	9,333
726060	Fm Lt Eq Fuel	273,646	226,462
726131	It 800 Mhz Maintenance	191,223	55,211
741015	Diesel Fuel	2,748,867	0

749014	Miscellaneous Chemicals	23,678	14,901
749016	Chlorine	954,137	1,020,173
749018	Ammonia	342,299	578,277
749019	Liquid Caustic Soda	1,360,382	1,351,275
749023	Lime	7,476,308	11,922,743
749024	Sodium Hypochlorite	1,560,211	1,633,636
749025	Silicate	277,819	373,485
749027	Sodium Polyphosphate	489,564	661,366
749029	Potassium Permanganate	169,264	310,644
749031	Polymers	141,509	199,649
749032	Polymeric Flocculant	0	0
749035	Liquid Carbon Dioxide	664,240	835,166
749037	Maint & Repair - Lab Instrument	4,300	175,140
749038	Chemical Inventory Adjustment	346,833	262,313
749039	Fluorosilicic Acid	298,103	296,724
749219	Laboratory Supplies	155,460	169,461
Total	***Water Treatment & Purification***	***28,481,936***	***32,668,807***

Water Transmission & Distribution

ACCOUNT	ACCOUNT NAME	2014	2015
722010	Electrical Services	2,163	1,846
722020	Natural Gas	1,952	834
722110	Water & Sewer Service	74,944	40,739
722123	Hazardous Waste Disposal	587,050	280,761
722130	Swm Charges Waste Disposal	5,962	9,105
726060	Fm Lt Eq Fuel	964,322	654,359
726131	It 800 Mhz Maintenance	191,223	55,211
Total	***Water Transmission & Distribution***	***1,827,615***	***1,042,854***

Appendix D - Wholesale Anomaly/Change-outs

MONTH	LOCATION	METER	NEW METER	SIZE	ANOMALY	NOTES
January	Hialeah Gardens	A1180979		4"	Out of Service	Estimated for 34 Days
February	Hialeah Gardens	A1180979		4"	Register Change	Estimated
May	C/O Miami Beach	10435		36"	Out of Service	Estimated for 29 Days
July	C/O Miami Beach	V-928808		16"	Out of Service	Estimated for 30 Days
	C/O West Miami	02419537		4"	Out of Service	Estimated for 31 Days
	Bay Harbor Islands	994163		20" Deduct	Out of Service	Estimated for 33 Days
August	C/O Miami Beach	161481		24"	Out of Service	Estimated for 30 Days
	C/O Miami Beach	V-928808		16"	Out of Service	Estimated for 30 Days
	C/O Miami Beach	10435		36"	Out of Service	Estimated for 30 Days
	C/O Miami Beach	40284			Out of Service	Estimated for 30 Days
	Bay Harbor Islands	994163		20" Deduct	Out of Service	Estimated for 28 Days
September	Bay Harbor Island	994163		20" Deduct	Out of Service	Estimated for 28 Days
	C/O North Bay Village	19989549	12105252	6"	Buried - Est. Zero	New meter
	C/O North Bay Village	1210736	15414837	4"	Buried - Est. Zero	New meter

	Homestead	64422275A / 64422275B	15514842		Change-out 10" & 2"	2 for 1 Change-out
	Bay Harbor Island	994163		20" Deduct	Out of Service	Estimated for 30 Days
October	Hialeah Gardens	A1180979		4"	Out of Service	Estimated 33 Days
	Surfside	7410512	15414836	2"	Meter Change-out	
	Surfside	7410511	15414839	2"	Meter Change-out	
December	C/O North Miami	1280881	15414879	8"	Meter Change-out	Slow Meter
	Village of Virginia Gardens	08416569		8"	Out of Service	Estimated for 29 Days

Appendix E – 2014/2015 Water Leak Comparison

	Main Line Leaks				Service Line Leaks				Valve Leaks				Hydrant Leaks			
	2014		2015		2014		2015		2014		2015		2014		2015	
Month	**BG**	**NBG**	**BG**	**NBG**	**BG**	**NBG**	**BG**	**NBG**	**BG**	**NBG**	**BG**	**NBG**	**BG**	**NBG**	**BG**	**NBG**
Jan	8	23	28	47	4	31	68	82	0	7	10	7	0	2		
Feb	12	34	23	82	17	37	96	84	2	4	3	21	0	1		
Mar	5	35	59	47	6	49	125	75	2	2	9	18	1	2		
Apr	4	55	25	68	0	57	53	126	2	9	5	22	0	2		
May	6	26	37	49	3	56	103	67	0	6	4	8	0	3		
Jun	7	46	55	27	3	44	72	75	0	0	6	7	0	1		
Jul	6	42	30	31	2	36	56	82	1	1	5	5	0	0		
Aug	4	54	6	79	0	54	70	91	0	3	0	11	0	5		
Sep	4	48	26	61	11	58	80	63	1	6	7	9	1	3		
Oct	4	35	37	28	4	54	52	99	2	5	2	11	0	2		
Nov	6	27	44	19	4	43	77	43	0	6	0	8	0	7		
Dec	4	30	10	48	6	38	43	101	2	6	1	13	0	1		
Totals	**70**	**455**	**380**	**586**	**60**	**557**	**895**	**988**	**12**	**55**	**52**	**140**	**2**	**29**	**0**	**0**

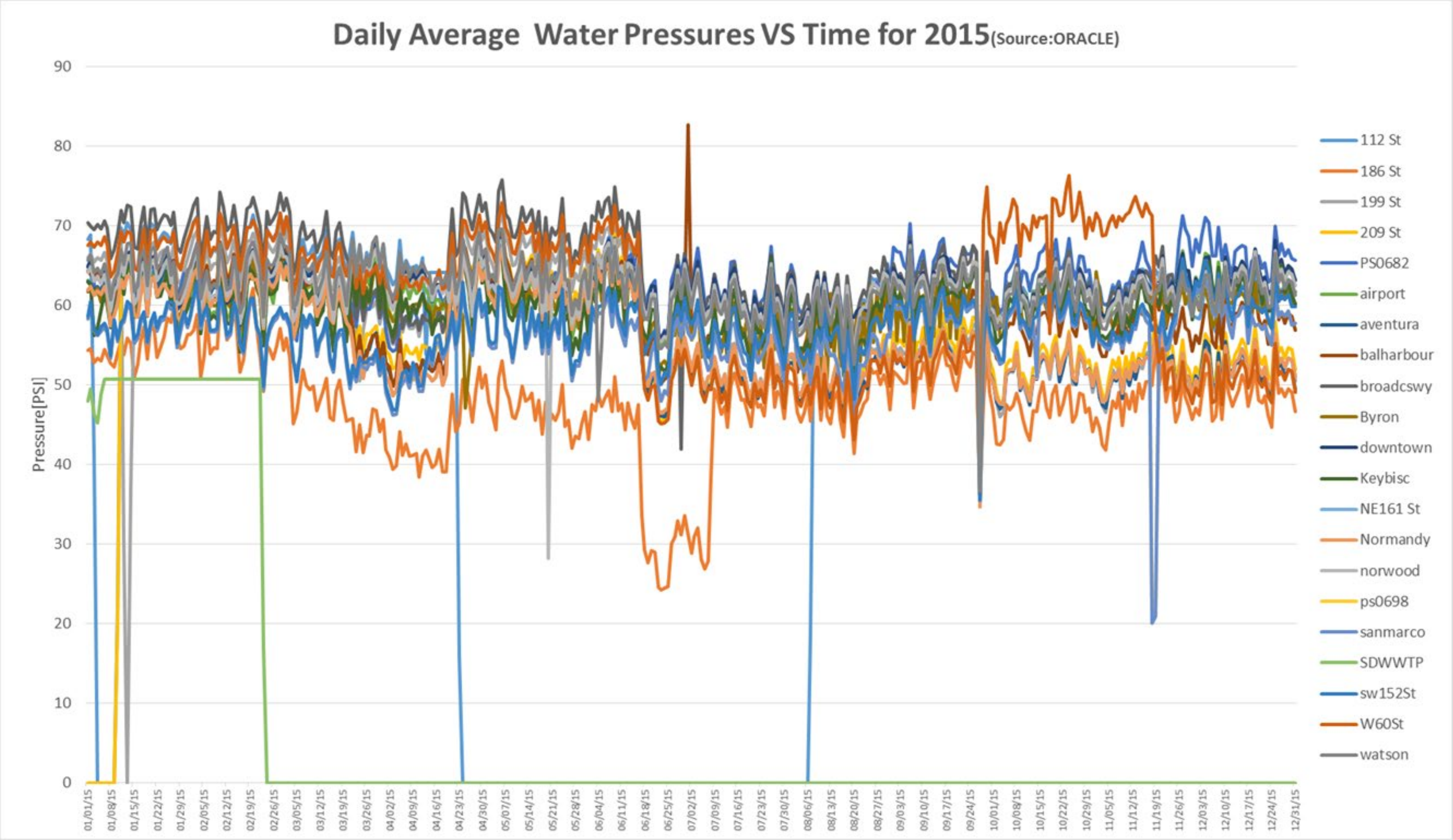
2014 = 1,240 Leaks (1,240 attributed to active leak detection program)

2015 – 3,041 Leaks (1,491 attributed to active leak detection program)

BG (Breaking Ground)
NBG (Non-Breaking Ground)

There Department realized a dramatic increase in "BG" or visible leaks in 2015. This was especially evident when comparing the 2014 main line and service line leaks to the 2015 main line and service line leaks.

Appendix F – Daily AVG water pressure chart



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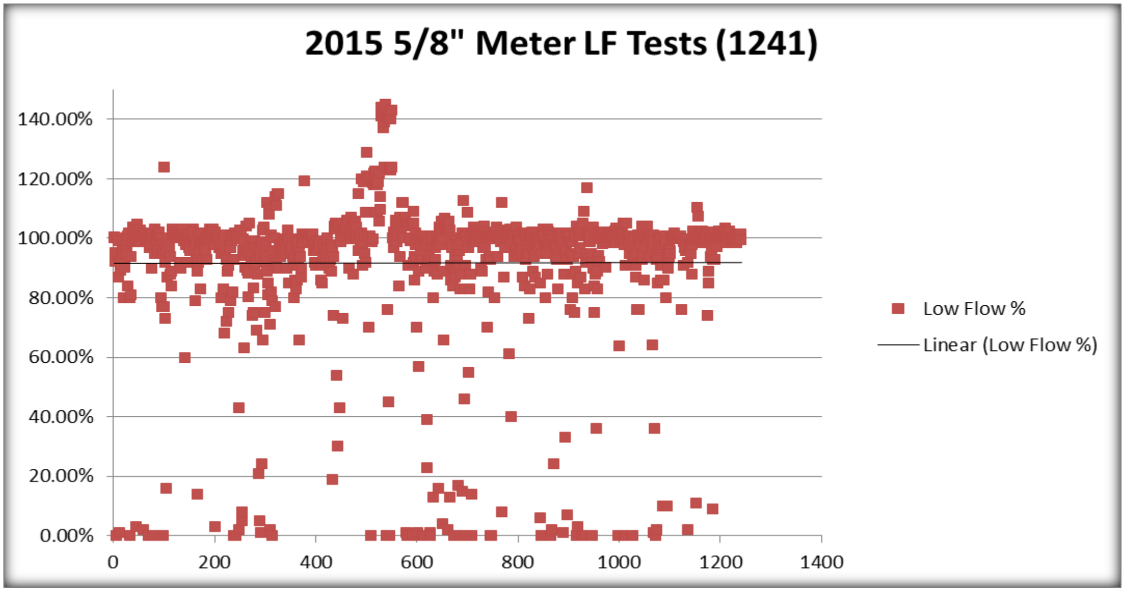
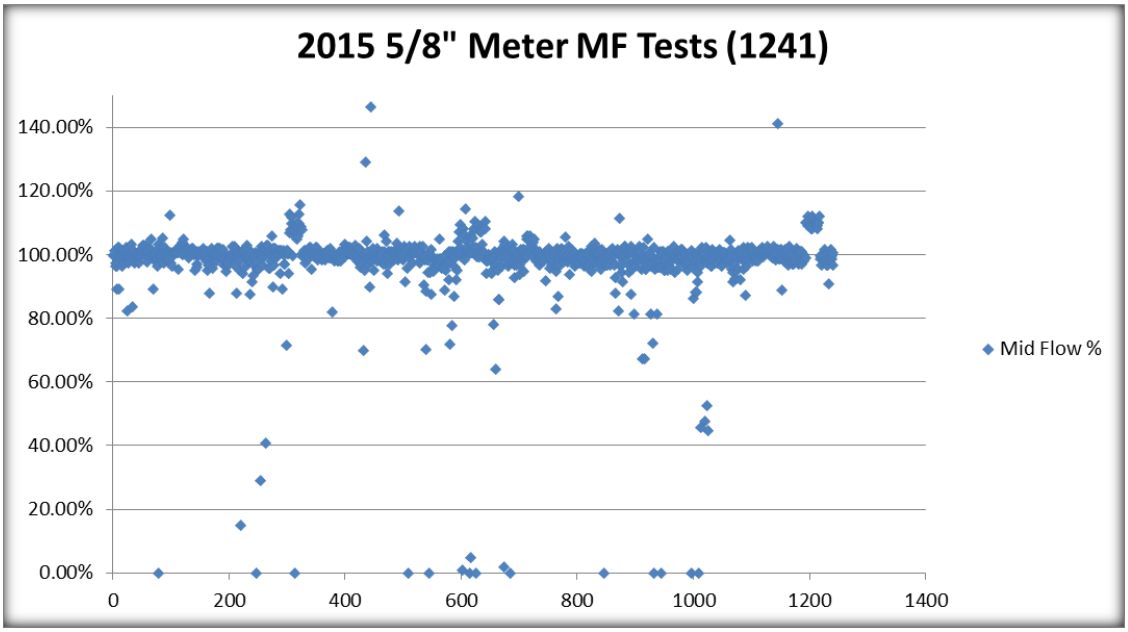
Appendix G - Meter Test Data

During 2015, 1,241 - 5/8" meters were tested at low, mid, and high flows. The volume through these meters was not reported. As diagramed in the charts below, the low flow tests resulted in an average accuracy of 91.7%. The average accuracy of the mid flow and high flow tests were 97.89%, and 98.31% respectively.

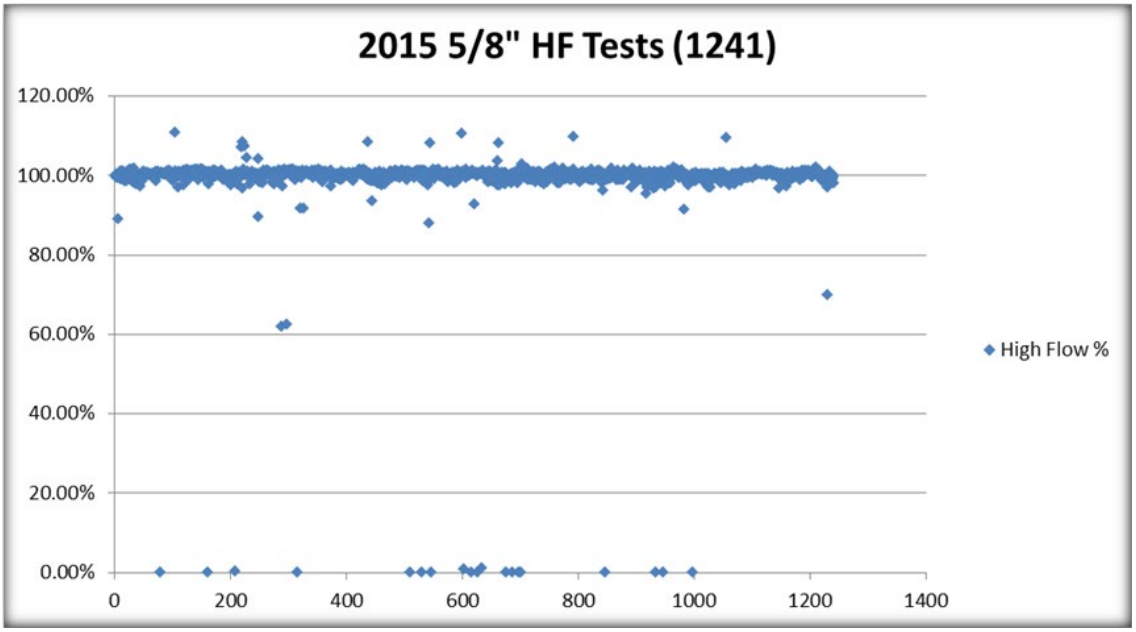
5/8" Meter – Low Flow Test



5/8" Meter – Mid Flow Test

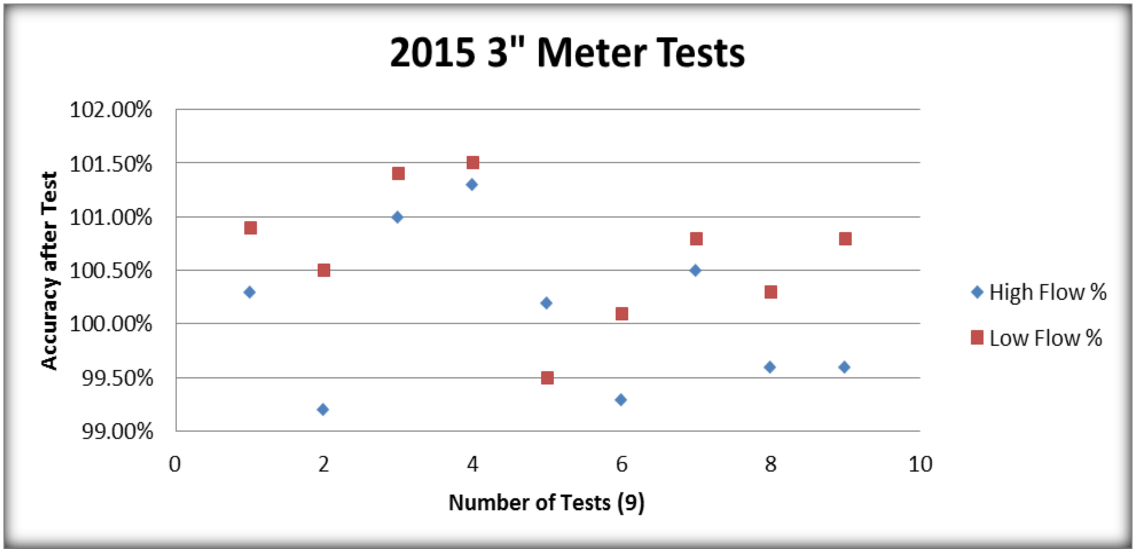


5/8” Meter – High Flow Test



There were nine tests conducted on eight 3” meters in 2015. These meters are tested at 2 flow rates and the average accuracy of all tests was 100.11% on the high flow test and 100.65% on the low flow test. See chart below for details of testing completed on 3” meters during 2015.

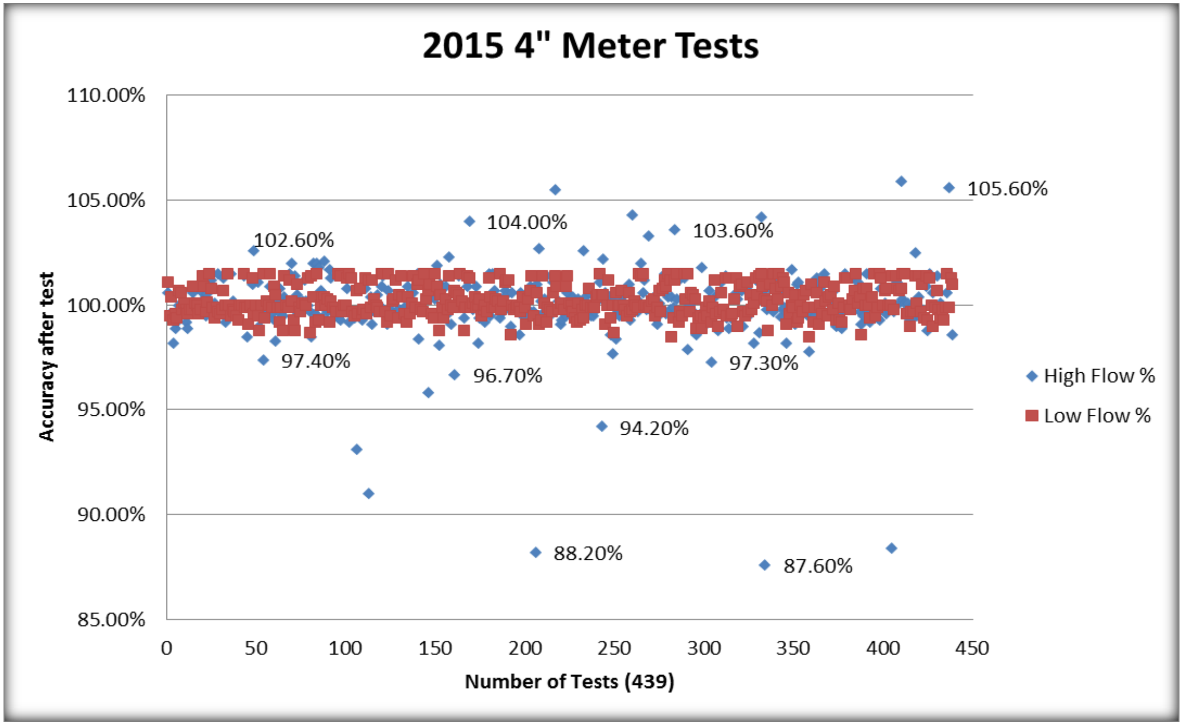
3” Meters (High & Low Flow Test Results)



The Department conducted 439 tests on 4” meters during 2015. 141 4” meters were tested more than once during 2015. 275 of the 439 tests occurred after August 1st, 2015. The average accuracy (as left – after repair/adjustment) of the high and low flows tested equaled 100% and 100.15%

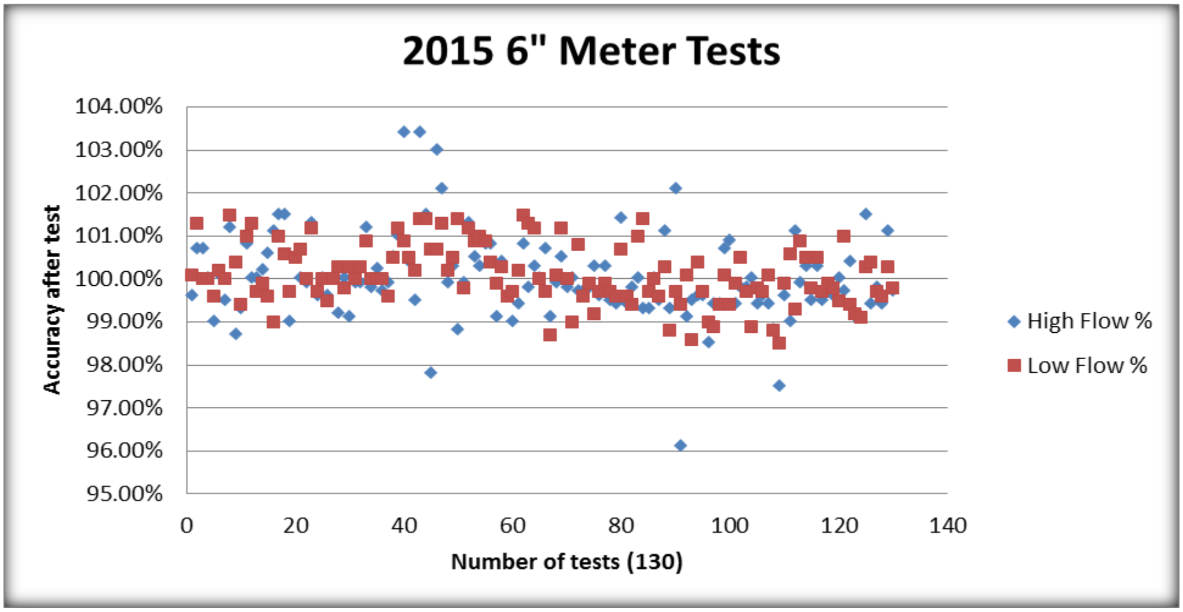
respectively. This frequency of testing will assist the Department to increase validation for future audits.

4" Meters (High & Low Flow Test Results)



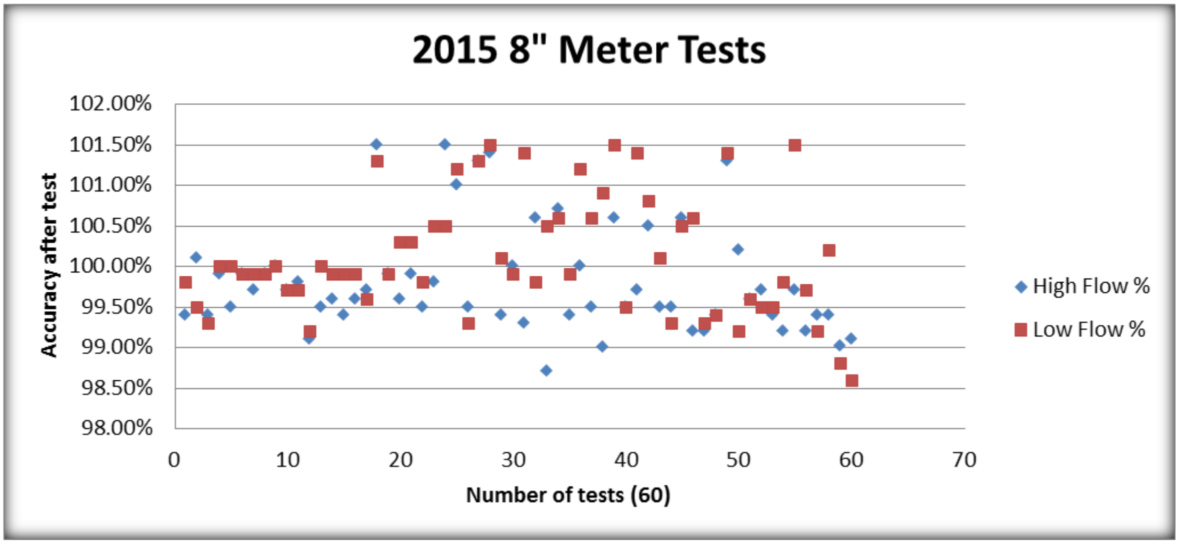
The Department conducted 130 tests on 6" meters during 2015. Of these meters, 95 were tested one time and 35 were tested more than once. The "as left" average accuracy result was 100.10% (Low flow) and 100.00% (high flow). As with the 4" meters, there are several meters that over-register and under-register, but the average of all tests were well within the Departments accuracy range.

6” Meters (High & Low Flow Test Results)



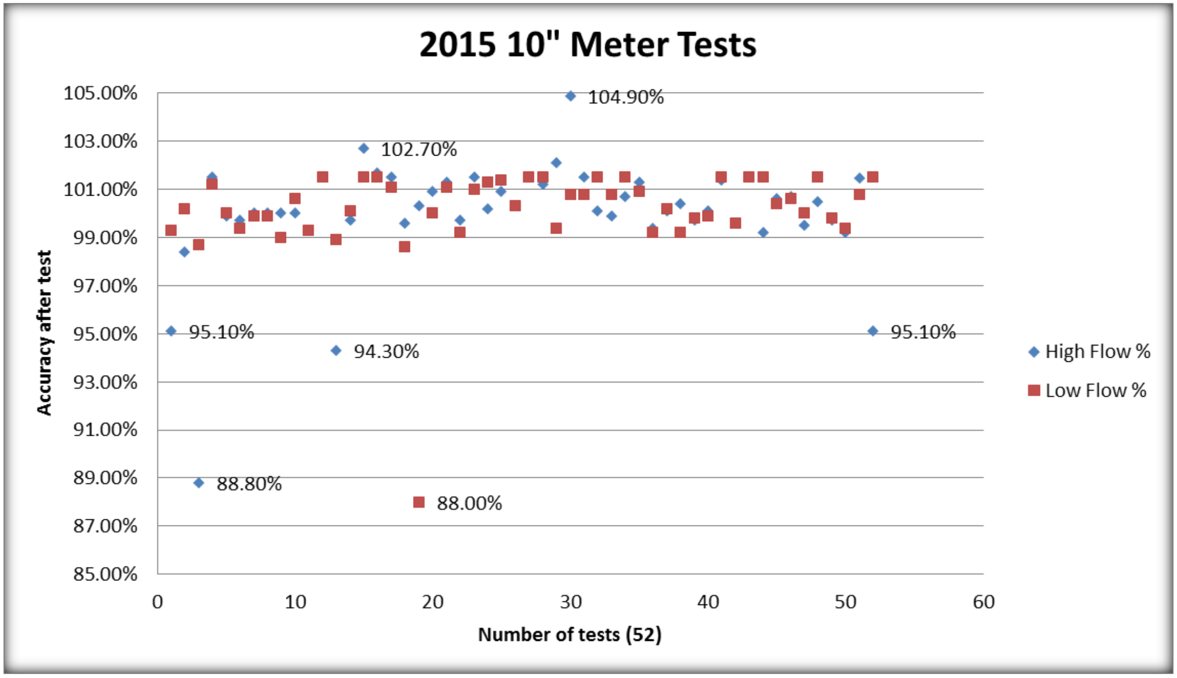
The Department completed 60 tests on 8” meters during 2015. The low flow test results were within 98.6% to 101.5% with an average accuracy of 100.11%. The high flow test results were within 98.7% to 101.5% with an average accuracy of 99.81%.

8” Meters (High & Low Flow Test Results)



The Department completed 52 meter tests on 10” meters during 2015. The low flow accuracy ranged from 88.00% to 101.5%. The average accuracy for the 10” low flow tests was 100.16%. Because of the high consumption that is generally registered through 10” meters, it is important to identify under-performing meters and repair or replace if necessary. Additionally, if a meter is found to be habitually inaccurate, it may be logical to decrease the time interval between tests. By increasing testing on problematic large meters, the loss of an under-registering meter is kept to a minimum.

10” Meters (High & Low Flow Test Results)



Appendix H - FY 2014/2015 Non-Residential Water Volumetric Rate (per 100 Cubic Feet)

NON-RESIDENTIAL METER SIZE	NON-RESIDENTIAL USAGE RATES	FY 2014 RATE (EFFECTIVE 10/1/2014)	FY 2015 RATE (EFFECTIVE 10/1/2015)
5/8"	0 to 5 CCF	$0.37	$0.37
	6 to 9 CCF	$2.75	$3.01
	10 to 17 CCF	$3.34	$3.56
	18 CCF and Over	$5.53	$5.88
1"	0 to 13 CCF	$0.37	$0.37
	14 to 23 CCF	$2.75	$3.01
	24 to 43 CCF	$3.34	$3.56
	44 CCF and Over	$5.53	$5.88
1.5"	0 to 25 CCF	$0.37	$0.37
	26 to 45 CCF	$2.75	$3.01
	46 to 85 CCF	$3.34	3.56
	86 CCF and over	$5.53	5.88
2"	0 to 40 CCF	$0.37	$0.37
	41 to 72 CCF	$2.75	3.01
	73 to 136 CCF	$3.34	$3.56
	137 CCF and over	$5.53	$5.88
3"	0 to 80 CCF	$0.37	$0.37
	81 to 144 CCF	$2.75	$3.01
	145 to 272 CCF	$3.34	$3.56
	273 CCF and over	$5.53	$5.88
4"	0 to 125 CCF	$0.37	$0.37
	126 to 226 CCF	$2.75	$3.01
	227 to 425 CCF	$3.34	$3.56
	426 CCF and over	$5.53	$5.88
6"	0 to 250 CCF	$0.37	$0.37
	251 to 451 CCF	$2.75	$3.01
	452 to 850 CCF	$3.34	$3.56
	851 CCF and over	$5.53	$5.88
8"	0 to 400 CCF	$0.37	$0.37
	401 to 722 CCF	$2.75	$3.01
	723 to 1,360 CCF	$3.34	$3.56

	1,361 CCF and over	$5.53	$5.88
10”	0 to 575 CCF	$0.37	$0.37
	576 to 1,038 CCF	$2.75	$3.01
	1,039 to 1,955 CCF	$3.34	$3.56
	1956 CCF and over	$5.53	$5.88
12”	0 to 1,075 CCF	$0.37	$0.37
	1,076 to 1,940 CCF	$2.75	$3.03
	1,941 to 3,655 CCF	$3.34	$3.56
	3,656 CCF and over	$5.53	$5.88
14”	0 to 2,000’ CCF	$0.37	$0.37
	2,001 to 3,610 CCF	$2.75	$3.01
	3,611 to 6,800 CCF	$3.34	$3.56
	6,801 CCF and over	$5.53	$5.88
16”	0 to 2,750 CCF	$0.37	$0.37
	2,751 to 4,963 CCF	$2.75	$3.01
	4,964 to 9,350 CCF	$3.34	$3.56
	9,351 CCF and over	$5.53	$5.88

Appendix I - Water Leak Detection Program Overview

Based on Black & Veatch's experience of conducting annual audits on the Department's Leak Detection Program, it is our opinion that the Department's program is one of the most effective in-house programs in the United States when compared to other utilities of similar size. It continues to evolve in order to stay as current and effective as possible to reduce non-revenue water loss. The Department's leak survey procedures and methods are unique as they utilize leak noise loggers to conduct a complete system review each year. In addition, the Department is able to complete a system wide survey every 10 months and perform all equipment maintenance and repairs in-house allowing quick turnaround time for re-deployment of equipment. The following is a brief explanation of the work flow for the Departments in-house leak detection program:

- The logger deployment route for 4 logger/survey technicians is planned by one individual in the office. This person provides system maps with proposed logger locations

- Four people review the route and deploy loggers at the proposed locations. If the access point that is identified on the route map is not easily accessible, the logger/survey technician will deploy the logger in the vicinity. Each technician is armed with 20 loggers
- The technicians program the 20 loggers to take readings shortly after the deployment. The technicians then lift and shift and program the loggers 3 more times. Each technician then brings the loggers (with 80 reads) to the shop for sound analysis. The water lines surveyed are managed by field markings on paper maps that are filed in the warehouse. The production of 80 reads per person is exceptional compared to other lift and shift programs
- One person in the shop is responsible for sound analysis of all 80 loggers (320 recordings). If the sound technician identifies a possible leak sound, he will create a work order that is sent to one of the 4 pinpointing technicians
- If the pinpoint technician locates a water leak, they create a work order in the field. The work order includes information to assist the repair crews understand the exact location of the leak. This work order is completed on an access database that is not tied to the EAMS. NOTE: the work order does not provide repair crews with any type of detail that would prioritize one leak repair over another
- A second work order is completed in the field by the repair crews during repairs. This work order is created in the EAMS. To understand the leak run times, the work orders must be pulled from each program for comparison. There is a field input on the repair work order that gives a brief overview of the condition of the pipe at the leak location (i.e. Fair). NOTE: there isn't a clear cause of failure analysis section on the work order but the field crew does provide measurements of the leak (split, whole, etc.) to help the Department track leakage.
- All program data is managed by one person. When the repair work order is completed by the field crew, he enters the leak size/type data into the database which then calculates the volume of the leak at 55 PSI. That value is then calculated to have been running for 180 days and that value is used for the internal non-revenue report. NOTE: the Department does not utilize GIS to help manage leak data. It is recommended the Department consider

using GIS to tie all information together in one location. This would make it much easier to pull reports.

The current staffing that completes the day to day tasks of the Leak Detection Program are listed below (excludes management personnel). The Department is currently considering the addition of one more pinpointing technician to work exclusively at night.

Current Leak Program Staffing

TASK	# OF PEOPLE
Route Planning	1
Logger Deployments	4
Sound Analysis	1
Leak Pinpointing	4
Data Management	1
Management	1

While the program is extremely effective and continues to set the bar for in-house programs, there are areas that the Department should consider improving to reduce real losses.

Leak Run Times - Prioritization

Because the leak detection crew is able to locate leakage much faster than crews can make repairs, it is recommended that all leak work orders identify the class or leak repair priority. By implementing this system, the Department should be able expedite the reduction of water being lost through large leakage. Also the Department is considering providing the program with one or two repair crews assigned specifically to the program. This would reduce the common occurrence of crews being pulled away from unreported leakage.

By managing all leak data (from survey routing to cause of failure analysis during repairs), the Department will be able to identify problematic areas which will help identify a more strategic survey. NOTE: Of the 435 grid maps (1 grid = 1 square mile) used for surveying, the Department has identified a 35 square mile area in the northern part of the system where leaks are likely to surface. This is probably due to the sandy soil common in that area where sound does not carry well enough for a logger survey to detect leaks. As a result, these 35 selected map pages are no longer surveyed annually. This strategic survey is good practice, but this section should still be surveyed every three to five years to insure that leaks are not escaping into storm drains etc.

Through careful data management, the Department will be able to expand on strategically surveying parts of the service area. The Department will likely be able to reduce loss further if problematic areas are surveyed more often than areas with minimal chances of leakage. It is still necessary to survey the entire system, but surveying problematic pipelines (galvanized or old cast iron) on a more frequent basis will reduce the system leakage more efficiently.

Appendix J - Water Use Permit