2013 ANNUAL WATER LOSS REDUCTION PLAN

Implementation Status Report

BLACK & VEATCH PROJECT NO. 182279

PREPARED FOR

MIAMI-DADE
COUNTY

Miami-Dade Water and Sewer Department

14 APRIL 2014

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1 Introduction

The South Florida Water Management District (SFWMD or District) requires the Miami-Dade Water and Sewer Department (MDWASD) to prepare an annual status report of its 20-year Water Loss Reduction Plan implementation, per Limiting Condition 49 of the Miami-Dade County Water Use Permit-Permit No. RE-ISSUE 13-00017-W of 16 July, 2012. The Department retained Black & Veatch Corp (Black & Veatch) to prepare the 2013 Annual Water Loss Reduction Plan Implementation Status Report (2013 Annual Status Report) and provide assistance with the Plan implementation in 2013. This document is the 2013 Annual Status Report, which includes water audits as required by Limiting Condition 49.

The MDWASD water system consists of three regional water treatment plants (WTPs), the South Dade Water System (a series of wellfields and five small treatment facilities), treated water storage and pumping facilities, and approximately 7,700 miles of water transmission and distribution pipelines. The regional facilities are the Hialeah, John E. Preston, and Alexander Orr, Jr. WTPs, which have a total 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 five small wellfields and treatment facilities, referred to as the South Dade Water System that 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 Leisure City (four wells), Everglades (three wells), Elevated Tank (two wells), Newton (two wells), and Naranja (one well) wellfields.

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 approximately 439,000 retail customers, and 15 wholesale customers in a service area of approximately 400 square miles

The overall annual average daily flow of the entire system is approximately 308 MGD. Raw water supply for the three 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.

Two new WTPs will provide additional capacity to the water system. The new Hialeah Reverse Osmosis (RO) WTP is owned jointly by the City of Hialeah and MDWASD. The RO plant will have an initial treatment capacity of 10 MGD and it is designed to have an ultimate capacity of 17.5 MGD. The raw water source for this plant will be the brackish Upper Floridan aquifer. The Hialeah RO WTP is expected begin service in the first half of 2014. The proposed South Miami Heights WTP will replace three of the small treatment plants of the South Dade Water System. This plant will be a 20 MGD membrane softening and RO plant and will have the capacity to treat water from both the Biscayne and Floridan aquifers. This plant is scheduled to go into service in 2015.

1.1 BACKGROUND AND SCOPE OF WORK

The Department's 20-year Water Loss Reduction Plan was based on an evaluation of the Department's water supply and demand for Fiscal Year (FY) 2005. On November 15, 2007, the SFWMD approved and issued the Department its Consolidated Public Water Supply (PWS) Water Use Permit (WUP) - Water Use Permit No. 13-00017-W.

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

In November 2010, the SFWMD issued a revised Water Use Permit No. RE-ISSUE 13-00017-W which expires in 2030.

In May 2011, the Department submitted a second application for a second permit modification to SFWMD pertaining to the Department's alternative water supply plan. The proposed modifications were requested based on current water use reductions, as a result of the lower than anticipated population growth, water loss reduction and the successful implementation of the Department's Water Conservation Plan, and permanent two day a week landscape irrigation restrictions by county wide ordinance. The County's finished water demand is now approximately 40 million gallons per day (MGD) lower than what was anticipated when the first 20-year water use permit application was submitted in 2007, and 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.

In July 16, 2012, the SFWMD issued a revised Water Use Permit No. RE-ISSUE 13-00017-W which expires in December 16, 2030. A copy of the revised WUP is included in Appendix C.

The Water Loss Reduction Plan recommended 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 associated annual value of water savings for the water loss reduction activities. Limiting Condition 49 of the revised WUP specifically applies to implementation of the approved Water Loss Reduction Plan. Key requirements of Limiting Condition 49 are:

- Quarterly determination of distribution system losses
- Annual reporting of distribution system losses on April 15 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
- Annual reporting of additional water loss reduction activities if water losses as defined by AWWA methodology exceed ten percent.

2 2013 Water Audit and Water Loss Overview

Both real and apparent losses are very important to the Department, specifically leakage of mains, and service lines, the accuracy of meters and the interaction/analysis of the customer billing system. The Department continuously is implementing improvements that can be made to enhance revenue and improve efficiency. In 2013, 699 more million gallons of water was estimated to be saved from leakage reduction compared with 2012.

2.1 WATER LOSS CONTROL IMPROVEMENTS IN THE AUDIT YEAR

2.1.1 Validation of Results

MDWASD has increased and improved its efforts over the past calendar year to more accurately understand and audit all the variables within the AWWA standard water audit. In order to make informed decisions a significant amount of meter testing, analysis of leakage and water supplies has improved the validation. The estimated validation utilizing the AWWA grading has decreased from 78 to 77 (out of 100) between 2012 and 2013. While this is a decrease in grading it actually signifies a better understanding of certain variables including a slightly more accurate description of grading in the financial audit of the system and unbilled metered usage. This results in improvement in the level of understanding of the water system. This, in conjunction with an overall reduction of water losses in the past year suggests that MDWASD is showing improvement in its water loss reduction plan. More detail can be found in Sections 2.3 and 3.1

2.1.2 Leakage Reduction

In 2013 there has been a continued focus on leakage reduction. The leakage control group has increased the frequency of surveys and continued night shift work to get access to sites not normally possible to survey during the day (busy intersections, etc.). Pilot schemes evaluating automation of leakage detection activities have also been initiated by testing acoustic leak noise loggers connected to data collector systems. The operations group has also continued to review the locations of different types of leakage in order to better understand the nature of leakage with respect to pipe material and size. This has also led to the start of a major dual main replacement project which targets small galvanized service lines which are localized in alleyways or behind homes. It was estimated that 699 million more gallons of water was saved by leakage reduction in 2013 compared to 2012.

2.1.3 Meter Testing and Replacement

The meter testing program has been continued in 2013 including both residential and commercial meters. This, coupled with the continuing production meter testing allows the Department to more accurately allocate the losses shown on the audit. Fewer residential meters were tested in 2013 as part of the accuracy analysis program compared with 2012 (which included a large amount of testing). The Department still conducts testing of many of the meters removed from service and all of those replaced into service after rehabilitation. Additionally age replacement calculations were conducted after detailed analysis of the 2012 data by staff interns in 2013. No specific changes were noted from the comparison and analyses so the inaccuracy was extrapolated to be very similar to that noted in 2012. More detail can be found in sections 3.1.3 and 6.1.3.

2.1.4 Asset Condition Assessment

The Pure Technologies condition assessment program targeted the large pre-stressed concrete cylinder (PCCP) transmission mains. In 2012 the Department completed inspection of all 120 miles of large diameter PCCP pipe in the water distribution system and successfully repaired/replaced 118 segments. Replacement or repair of some of the pipe has proved extremely challenging due to special work that needs to take place prior to any repair work, especially in areas where there is no ability to isolate sections of pipe.

The Department is currently deploying technologies that permit the inspection of live lines without interrupting the water services. Water transmission lines are being inspected and condition assessment reports are being provided to manage failure risk of critical pipelines.

2.2 ESTIMATED WATER SAVINGS

Part of the WUP is to prove the level of water savings and continually improve water loss control through 2030. The 2013 audit data shows that there was a real loss savings of seven gallons per connection per day, or a total additional savings of approximately **699 million gallons** in 2013 compared with 2012.

This level of savings needs to be trended over time to prove out that the savings are consistent and improving the system's efficiency.

As the understanding of the losses (both real and apparent) improves, these audit values may change. However, overall improvement appears to be valid and is matched by the evidence of increased focus on meter testing, leak detection and asset condition assessment.

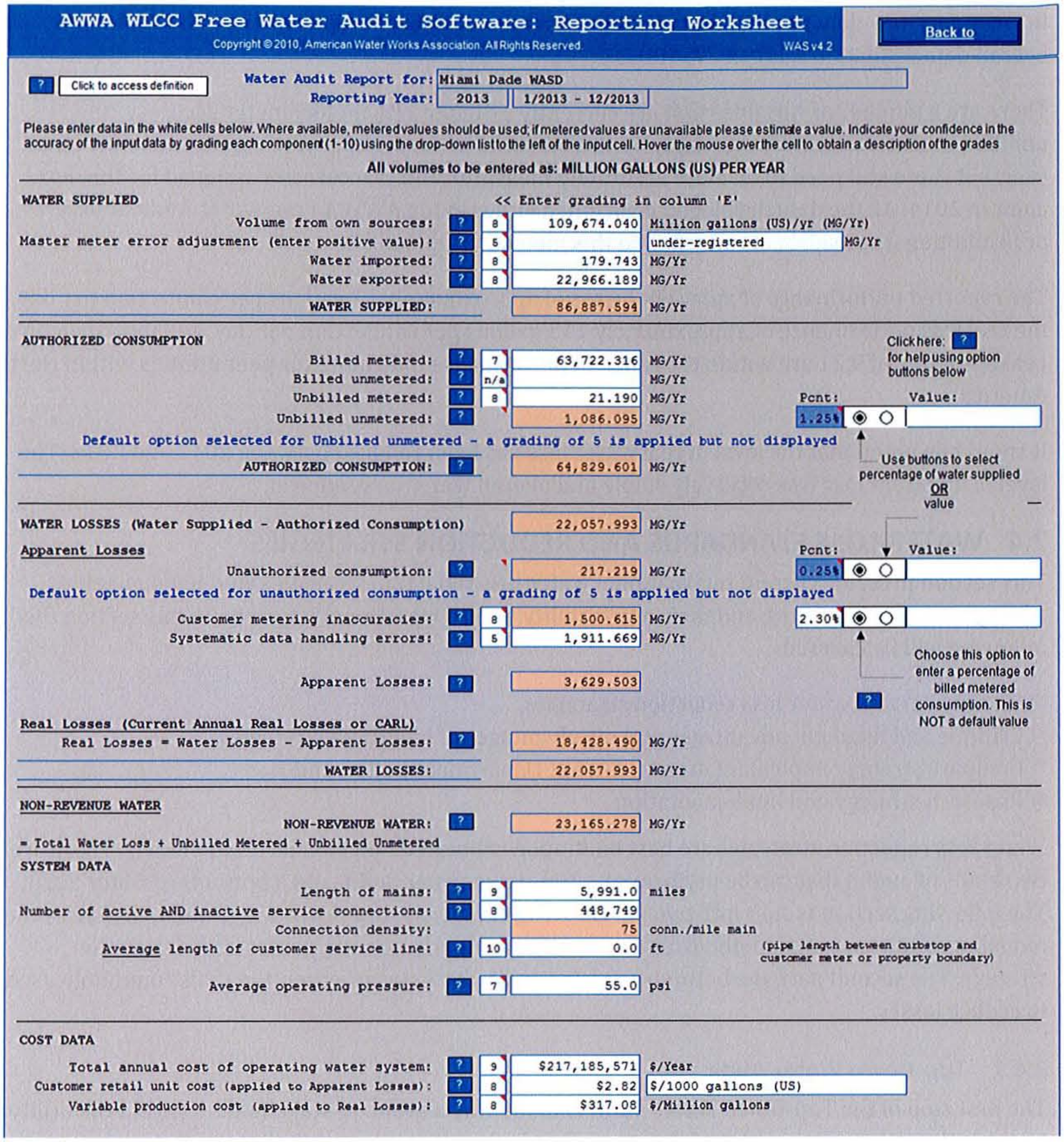
2.3 AWWA WATER BALANCE ANALYSIS OVERVIEW

The water balance was created using the AWWA Software, and analysis of existing data provided by the Department. The 2013 data in comparison to 2012 data are shown on Table 2-1. It should be noted that there are still a few areas where data validation needs to be improved to prove out the performance indicators. However, it does appear as though the utility has begun to improve in its reduction of water losses.

Table 2-1 Standard AWWA Water Balance Analysis

PERFORMANCE INDICATOR (PI)	UNITS	2011	2012	2013
Total NRW (% by volume)	%	30.2%	27.9%	26.7%
Apparent Loss	Gallons/conn/day	44	22	22
Real Loss	Gallons/conn/day	126	120	113
AWWA grading	(1-100)	73	78	77

Figure 2-1 shows a screenshot of the completed AWWA Free Water Audit Software© for 2013. All the data for the Figure 2-1 were developed from the information provided by the Department, and flow and billing records analyzed for calendar year 2013. The detailed reporting worksheets for the audit are found in Appendix B.



AWWA WLCC Free Water Audit Software: Reporting Worksheet

Copyright © 2010, American Water Works Association. All Rights Reserved. WAS v4.2

Water Audit Report for: Miami Dade WASD
Reporting Year: 2013 | 1/2013 - 12/2013

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 (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

WATER SUPPLIED << Enter grading in column 'E'

Volume from own sources:	8	109,674.040	Million gallons (US)/yr (MG/Yr)
Master meter error adjustment (enter positive value):	5		under-registered MG/Yr
Water imported:	8	179.743	MG/Yr
Water exported:	8	22,966.189	MG/Yr
WATER SUPPLIED:		86,887.594	MG/Yr

AUTHORIZED CONSUMPTION

Click here: ? for help using option buttons below

				Pcnt:		Value:
Billed metered:	7	63,722.316	MG/Yr			
Billed unmetered:	n/a		MG/Yr			
Unbilled metered:	8	21.190	MG/Yr			
Unbilled unmetered:		1,086.095	MG/Yr	1.25%	● ○	

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

AUTHORIZED CONSUMPTION:		64,829.601	MG/Yr

Use buttons to select percentage of water supplied
OR
value

WATER LOSSES (Water Supplied - Authorized Consumption) 22,057.993 MG/Yr

Apparent Losses

				Pcnt:		Value:
Unauthorized consumption:		217.219	MG/Yr	0.25%	● ○	

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

Customer metering inaccuracies:	8	1,500.615	MG/Yr	2.30%	● ○	
Systematic data handling errors:	5	1,911.669	MG/Yr			
Apparent Losses:		3,629.503				

Choose this option to enter a percentage of billed metered consumption. This is NOT a default value

Real Losses (Current Annual Real Losses or CARL)

Real Losses = Water Losses - Apparent Losses:		18,428.490	MG/Yr
WATER LOSSES:		22,057.993	MG/Yr

NON-REVENUE WATER

NON-REVENUE WATER:		23,165.278	MG/Yr

= Total Water Loss + Unbilled Metered + Unbilled Unmetered

SYSTEM DATA

Length of mains:	9	5,991.0	miles
Number of active AND inactive service connections:	8	448,749	
Connection density:		75	conn./mile main
Average length of customer service line:	10	0.0	ft (pipe length between curbstop and customer meter or property boundary)
Average operating pressure:	7	55.0	psi

COST DATA

Total annual cost of operating water system:	9	$217,185,571	$/Year
Customer retail unit cost (applied to Apparent Losses):	8	$2.82	$/1000 gallons (US)
Variable production cost (applied to Real Losses):	8	$317.08	$/Million gallons

Figure 2-1 Water Audit software for CY 2013

Section 3 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 4.2) has been used to calculate all the required indicators. This is then used to develop an overall water balance, and relevant performance indicators. 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 MDWASD, and are for the Calendar Year 2013.

In overview the data provided by MDWASD appears to be of good quality and validation. The overall data validation score of 77/100 is good.

There are a number of variables that are currently estimated (including meter accuracy, and unbilled unmetered water). Age analysis and on-going meter testing were conducted in the audit year, but these still need to be more accurately measured and inaccuracies assigned for the next audit in 2014. All the data developed is included either in the AWWA Free Water Audit Software©, or in additional spreadsheets attached to this memo in Appendix B.

The reported performance of apparent losses of approximately 22 gallons per connection per day, the real loss performance of approximately 113 gallons per connection per day, and Infrastructure Leakage Index of 9.21 are within the range of performance indicators for peer utilities within North America.

It should be noted that the level of real water loss has been reduced between 2012 and 2013. The level of apparent loss was relatively stable and overall water loss reduced.

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, and
- 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

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 (top-down) level. Figure 2-2 shows the major components of the most current AWWA/IWA standard water balance model.

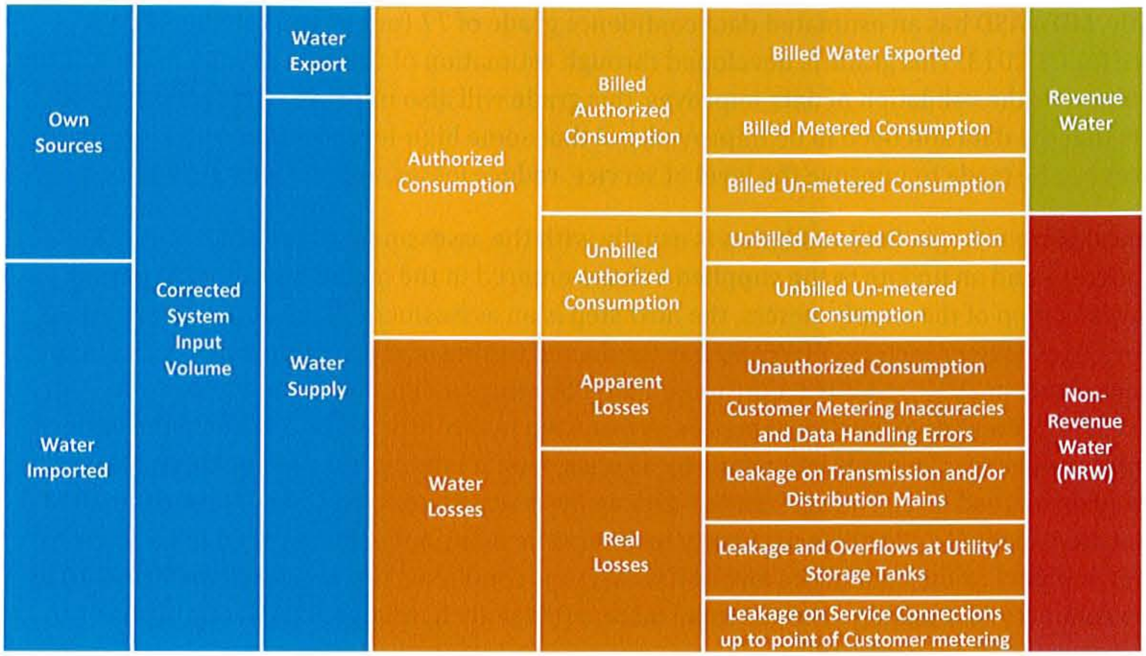


Figure 2-2 The Standard IWA Water Balance

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 4.2, 2009). 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.

Currently, MDWASD has an estimated data confidence grade of 77 (out of 100) on the AWWA software for CY 2013. This grade is developed through estimation of the data validity of each of the input values. As the validation of data improves, this grade will also improve. The current grade suggests that the data still need to be improved, but that some high-level decisions on targeting of resources can be made to improve the level of service, reduce losses, and enhance revenue.

One typical place to begin field validation is usually with the assessment of the accuracy of the supply meters, and an update to the supplied volume entered in the model for the audit period. After investigation of the supply meters, the next step is an assessment of the accuracy of various categories of consumer meters. MDWASD has conducted testing of all the supply meters from the treatment plants in 2012 and 2013. 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. This is usually done by a series of data mining tasks. While this has been completed on a broad level, and age-related data analysis was conducted by staff interns in 2013, more detailed analysis will still be necessary to determine if any adjustments need to be made to the input numbers or the confidence level. MDWASD has conducted tests on small meters in 2013 and also conducts field testing of larger retail meters (three-inch or larger) on a rotating basis to ensure these meters are accurate.

2.4.3 Performance Indicators

Another component of the water balance model in addition to confidence levels is the existence of performance indicators (PIs). The new standard audit provides performance indicators for all of the water loss components, as well as for some of the basic financial indicators (Table 12). As the audit is refined over time, additional PIs can be incorporated to expand the scope and depth of the analysis. The use of various indicators, as opposed to the old practice of using a percentage loss based on the total water supplied, allows the utility to accurately produce baseline data, track performance, and set targets with priority on the components of water loss that will reap the most cost effective returns.

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.

Table 2-2 Details of Selected Key Performance Indicators

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	

COMPONENT	TYPE	BASIC PI	DETAILED PI
Real Losses		Gallons/service connection/day	Infrastructure Leakage Index (ILI)
	System Operational	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	

Key PIs recommended for use in the MDWASD water loss management study are:

- Apparent Losses (Gallons/service connection/day, and lost revenue),
- Real Losses (Gallons/service connection/day, and lost revenue), and
- 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 start understanding and calculating these PIs, below are definitions of the performance indicators, 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 volumes of loss to economic levels.

There are additional targeted PIs which can be used by MDWASD 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 Data Analysis

The AWWA Free Water Audit Software© (version 4.2) has been used to calculate all the required indicators. This is then used to develop an overall water balance, and relevant performance indicators 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. Information on the validation methods and rankings in the software are copied in Appendix B. The following sections are structured to follow the in the format of the standard water balance as described in the previous section 2.4 and depicted in Figure 2-2. The following categories of the report are the focus for the 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, and** (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 CY 2013.

This data which is used to determine the following inputs should be validated by MDWASD staff on a regular basis to ensure inputs are as accurate as possible. Additionally, this audit needs to continue to be conducted 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.

3.1.1 Water Supplied

Total Water Supplied = 86,887.594 Million gallons

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

Volume from Own Sources

This includes all the volume from the water treatment plants.

The details of production utilized for the audit were obtained by summarizing SCADA pumpage data. MDWASD provided SCADA data with daily system pumpage for both the raw water from the wells and for the influent and finished water from the treatment plants. This pumpage data was used as an approximation of the produced volume.

The total produced volume for 2013 was recorded as 109,674.040 million gallons.

Master Meter Error Adjustment

No additional evaluation of the electronic or flow test calibration records were conducted in this initial review. However, analysis of the Alexander Orr , Jr. Plant (Orr), Hialeah and John E Preston

(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%). Data from all the calibrations and the analysis of error is discussed in Section 4.1.1. Since all the values are within the calibration limits the assumption is that the meters are accurate and so there is no master meter error adjustment. Full analysis of the flow regime in each venturi and development of a weighted average meter error was not conducted in CY2012 or CY2013 because all the meters were measured within tolerance.

The total master meter error adjustment assigned for CY 2013 was recorded as 0 million gallons.

Imported Water

In 2013, MDWASD imported water from two suppliers – the City of Homestead and the City of North Miami Beach. These provide water to locations within the Department's system that are difficult to reach with the current pumping system. In 2013, 179.74 million gallons were provided by the two utilities to the Department.

The value for 2013 was recorded as 179.74 million gallons.

Exported Water

MDWASD sells water to both retail and wholesale customers. The MDWASD has 15 water wholesale customers and at the end of CY 2013, 448,749 retail water customers (which includes 428,631 active and 20,118 inactive connections). These wholesale uses were summarized from the MDWASD wholesale records from metered sales data from 2013. The list of wholesale entities is shown in the table below with their respective annual use in 2013.

Table 3-1 Miami-Dade Water and Sewer Department Water Treated and Water Sales

Calendar Year 2013 Units - thousand gallons

WATER SYSTEM	
Water sold by customer	
Wholesale customers	
Hialeah	9,309,499
Miami Beach	7,918,235
North Miami	1,652,264
Opa-Locka	876,409
Hialeah Gardens	606,074
Bal Harbour	506,645
Medley	470,932
North Bay Village	414,629
Bay Harbor	324,682
Surfside	291,636
West Miami	232,668

WATER SYSTEM	
Homestead	148,331
Indian Creek Village	113,846
Virginia Gardens	100,115
North Miami Beach	224
Total Wholesale	**22,966,189**
Retail	63,722,316
Total water sold	**86,688,505**

Source: MDWASD

The total water sold to wholesale customers in 2013 was recorded at 22,966.189 million gallons

Other Water Supplied notes

There are no other known water supplies, other than the ASR wells which are used for testing, but not connected to the supply system currently. The new Hialeah reverse osmosis treatment plant will be operational in 2014, and did not provide water to the MDWASD distribution system in 2013.

Table 3-2 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 calibrated annually, occasional flow testing conducted

3.1.2 Authorized Consumption

Total Authorized Consumption = 64,829.601 Million gallons

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

Authorized consumption includes the volume of water taken by registered customers, the water supplier, and others who are authorized to do so by the water supplier, for any purpose. 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.

Billed Metered Consumption

The billed metered consumption is 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, and these are not calculated in this audit). Miami Dade 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 2013 was recorded as 63,722.316 million gallons.

Billed Unmetered Consumption

There is reportedly no billed unmetered consumption.

The value for Billed Unmetered Consumption in 2013 was recorded as 0 million gallons.

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, parks, fountains etc. In CY2012 this was an estimation based on reviews of other utilities. In CY2013 metered data from the treatment plants was recorded and utilized for this volume input.

The value for Unbilled Metered Consumption in 2013 was recorded as 21.190 million gallons.

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). Therefore a default has been developed within the water audit software to allow an approximate calculation using validated data from other systems. In this initial audit this default of 1.25% of water supplied has been chosen.

The value for 2013 was recorded as 1,086.095 million gallons.

Other Authorized Consumption notes

Water treatment plants do have a requirement to use water in certain situations (backflushing, etc.). However, it is anticipated that all these locations occurred prior to the finished water meter. Therefore this data is not included in this water audit.

Table 3-3 Authorized Consumption Validation Grading

GRADED VARIABLE	GRADING	REASONING
Billed Metered	7	Good billing systems, extensive meter accuracy testing although slightly reduced in 2013. Regular replacement of oldest meters
Billed Unmetered	n/a	No billed unmetered consumption reported
Unbilled Metered	8	Meters are read and maintained, analysis of unbilled uses conducted in 2013 compared with estimates in 2012. Still need to evaluate testing and billing procedures for unbilled properties
Unbilled Unmetered	-	The default was used for this variable

3.1.3 Water Losses

Total Water Losses = Total Water Supplied – Total Authorized Consumption
= 22,057.993 Million gallons

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

Apparent Water Losses

Total Apparent Water Losses = 3,629.503 Million gallons

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

Unauthorized Consumption

Unauthorized consumption includes all uses not authorized by the Department, including illegal use of hydrants, bypasses etc., as well 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 2013 was recorded as 217.219 million gallons.

Customer Meter Inaccuracies

All the meters three inches and larger are anticipated to be tested and repaired or replaced (if necessary) at least every three years. 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-inch to 2-inch meters may be necessary to prove out the accuracy of these groups of meters. Testing should analyze both meter age, throughput (volume through the meter), and if possible the average pressure for the location of the meter.

A high-level evaluation was performed to review water meter accuracy data from studies developed between 2008 through 2012 and to outline any potential issues for the MDWASD. Reporting and test data reviewed included.

- Comparison of current Department practices for meter testing and replacement with industry standards;
- Review of meter testing procedures and provide recommendations for developing an ongoing and dynamic performance-based meter testing program. The performance-based meter testing program should have the capability to periodically update and refine the degradation curves for residential meters.
- Practice of Large meter testing in-situ (in the field) by a dedicated testing crew.
- The testing includes a portable meter tester which is connected to the downstream test port for the duration of the test.
- Field crews all follow AWWA guidelines for the testing limits and frequency of tests.

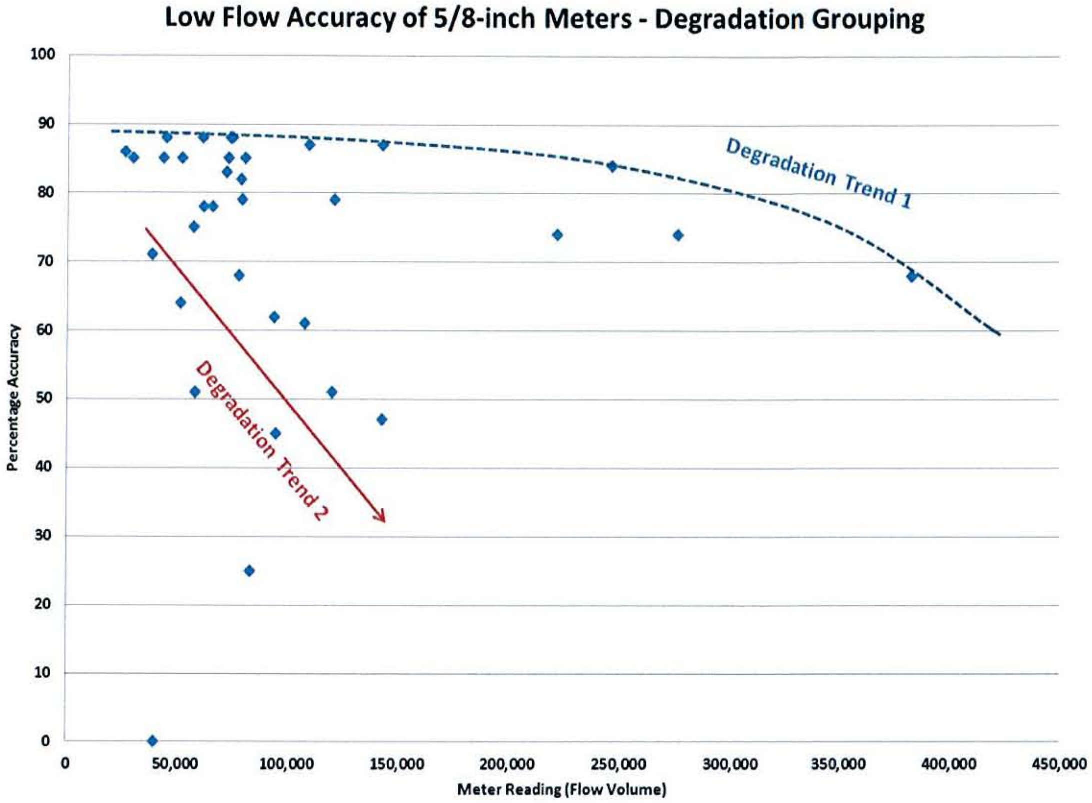


Figure 3-1 Example Meter Accuracy analysis of degrading meters (below 90% accuracy) from 2012 5/8-inch meter tests

An estimate of 2.3% (1,500.615 million gallons) underreporting across the meter stock has been used for this audit. This suggests meters of varying age and reliability and a slight increase in meter inaccuracy due to the overall meter stock ageing between 2012 and 2013.

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, specific triggers built in to track potential data handling errors are built in 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 3% of water supplied, or 1,911.669 million gallons has been used for this variable.

Table 3-4 Water Losses Validation Grading

GRADED VARIABLE	GRADING	REASONING
Unauthorized Consumption	-	The default was used for this variable
Meter Inaccuracies	8	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
Data Handling Errors	5	This is an estimate assuming a complex billing system

3.1.3.1 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 the review of system data and leak detection programs the Water Distribution Division collects and estimates leakage and authorized uses. These values are matched to the software calculation to act as a validation tool.

The Department has, however, conducted a significant amount of leak detection during the audit year. This appears to be improving efficiency and will continue to be monitored in future years. A listing of the equipment used on a daily basis is outlined in Table 3-5.

Table 3-5 Leak Detection Equipment Summary

EQUIPMENT	TYPE (MANUFACTURER/MODEL)	QUANTITY
ELECTRONIC SOUND AMPLIFIER	AQUASCOPES / HEATH CONSULTANTS	9
ELECTRONIC SOUND AMPLIFIER	STETHOPHON 04 /SEWERIN-HERMANN	5
ELECTRONIC SOUND AMPLIFIER (WIRELESS)	AQUATEST T-10 /SEWERIN-HERMANN	4
ELECTRONIC SOUND AMPLIFIER	LD15/ SUBSURFACE INSTRUMENTS	2
MECHANICAL SOUND AMPLIFIER	GEOPHONES / HEATH CONSULTANTS	5
MECHANICAL SOUND AMPLIFIER	GEOPHONES / SEWERIN-HERMANN	6
UNDERGROUND LINE LOCATOR	SURE-LOCK / HEATH CONSULTANTS	7
ELECTRIC DRILLS	BOSCH	6
METAL LOCATOR	ML-1M / SUBSURFACE INSTRUMENTS	1
METAL LOCATOR	PIPEHORN 800-HL	1
SOUND CORRELATOR	LC2500 / SUBSURFACE INSTRUMENTS	2
SOUND CORRELATOR	SECORR 08 /SEWERIN-HERMANN	3
SOUND CORRELATOR	ACCUCORR 3000 / FCS	1
CORRELATING LOGGER	SEPEM02/SEWERIN	98
CORRELATING LOGGER	SOUNDSENS/FCS	36
CORRELATING LOGGER	SEBA KMT	10

EQUIPMENT	TYPE (MANUFACTURER/MODEL)	QUANTITY
CORRELATING LOGGER	GUTERMANN ZONESCAN 820 ALPHA	10
CORRELATING LOGGER	PERMALOG/FCS	100

In addition to the standard or normal leakage detection activities the Department conducted pilot studies of two types of acoustic leak noise loggers. These 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.

Gutermann Zonescan 820 Alpha system and SebaKMT were tested. The Gutermann system found leaks which were verified and staff are continuing to utilize this system to monitor and pro-actively search for leaking mains and service lines. The Seba KMT system had some operational issues and operation was discontinued.

The Gutermann system utilizes a collector system which sends the leak data to a central server which can be accessed in real time. This can be used to assess if the logger reports a leak, the noise at that location can be recorded and listened to and a correlation signal can also be sent to the server for analysis. Currently the pilot consists of 10 operating units and expansion of this operation will be considered in future years after full analysis of the system effectiveness.

The recorded value of real loss in the audit is 18,428.490 million gallons.

Total Real Water Losses =18,428.490 Million gallons

3.1.4 System Data

Length of Mains

MDWASD's water system consists of three regional water treatment plants (WTPs), the South Dade Water System (a series of well fields and 5 small treatment facilities), 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 5,991 miles and is the value used in the audit. The regional water treatment facilities are the Hialeah, John E. Preston, and Alexander Orr, Jr. WTPs, which have a total combined rated treatment capacity of 473 MGD.

Number of Service Connections

The number of service connections includes both active and inactive service lines. This value was calculated by the customer services department in 2013 and includes 448,749 connections. This was an increase of approximately 10,000 connections compared with 2012. The 2013 numbers were calculated with more accurate data and active and inactive connections were counted separately. In 2012 this was a calculation using the amount of active accounts and adding a small percentage (2.5%) of inactive accounts to estimate the total.

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).

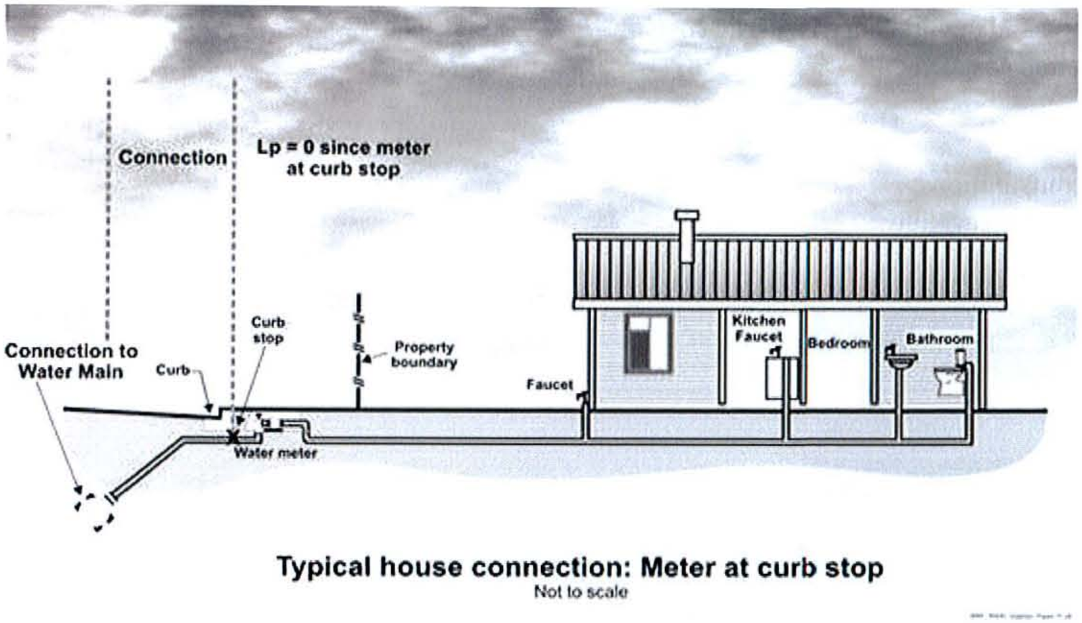


Figure 3-2 Average length of Service Line, Meter at the Curb Stop (source: AWWA Software)

Average Operating Pressure

The average operating pressure was estimated from a large amount of field operations data from tests within the distribution system. Analysis of the hydraulic model was also conducted to give a second opinion. This provided a value of just over 56 psi. However, since 55 psi is used in all the water loss calculations it was decided that the difference was not great enough to warrant a change. An average system pressure of 55 psi was used for this audit.

Table 3-6 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	8	Good billing records, uncertain policies and procedures
Customer Service Line	10	All services at property boundaries (therefore zero (0) value)
Average Operating Pressure	7	Utilized operations average which was near validated by analysis of the hydraulic model.

3.1.5 Cost Data

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 and system. Based on the Department's water system financial statements for the CY 2013 the total annual cost of operating the water system was derived from the following components:

- Operations and maintenance incurred costs
- Depreciation costs

Less:

- Capital contributions
- Non-operating revenue

Table 3-7 Operating Cost Details 2013

TOTAL COST	CY 2013
O&M	146,476,663
Depreciation	70,708,908
Total Annual Cost	**$217,185,571**

Source: MDWASD

Because the Department operates on an October through September fiscal year, financial statements from FY 2013 and FY 2014 were utilized to develop CY 2013 financial data. The full annual cost utilized for the audit is the total operating costs including operating and maintenance expenses and depreciation. The total cost of operating the water system did increase slightly between 2012 and 2013 and would have increased more if inventory of chemicals (purchased in CY 2012 and used in CY 2013) had not offset the increase.

In 2013 the overall cost of running the water system (including depreciation) was $217,185,571.

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, MDWASD'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 2013 were approximately $179.8 million.

Table 3-8 Retail Unit Cost CY 2013

RETAIL UNIT COST	CY 2013
Metered Sales-Residential-Watr	$56,506,719
Metered Sales-Multi Family-Wtr	$25,237,024
Metered Sales-Res Sprink-Wtr	$4,090,029
Metered Sales-Commercial-Water	$70,739,660
Metered sales-WASD Wtr facilit	$359,492
Metered Sales-NonResSprink-Wtr	$8,096,633
Metered Sales-Marina-Water	$49,899
Metered Sales - Firelines	$154,352
Water Conservation Surcharge for Excess Water Usage	$14,605,788
Total Retail Water Sales	**$179,839,596**
Billed Water (1,000 gallons)	63,722,316
Retail Unit Cost of Water Sold	**$2.82**

Source: MDWASD

Total billed water for 2013 was approximately 64,000,000 thousand gallons. Customer retail sales divided by the associated billed water for 2013 results in a customer retail unit cost of $2.82 per thousand gallons.

MDWASD has an inclining block water conservation rate structure for all its residential customers. The table below shows the current volumetric rate structure for a water customer:

Table 3-9 FY 2013 Water Volumetric Rate

ORDINARY COMMODITY CHARGE	2013 RATE (PER 100 CUBIC FEET)
0 to 5 hundred cubic feet	$0.37
6 to 9 hundred cubic feet	$2.25
10 to 17 hundred cubic feet	$2.92
18 and over hundred cubic feet	$3.86

In this audit the main retail rate from 2013 of $2.92 per hundred cubic feet (CCF) is the most likely rate where losses would be set as average monthly use is estimated by the Department to be 9 CCF per month or 27 CCF per quarter for a normal residential customer (note that residential customers are billed on a quarterly basis). In order to further validate this, a review of the metered sales against billed metered water was also conducted and an average of $2.82 per 1000 gallons was calculated. The calculated average was used in the calculations as it is a more conservative value of what cost could be recovered.

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 including variable costs of source of supply, power and pumping, purification, and distribution divided by the total volume of water supplied to the water distribution system including imported water.

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 $34.8 million in 2013.

Table 3-10 Variable Production Cost 2013

MARGINAL COST	CY2013
Water Source of Supply	$4,052,669
Water Pumping	$1,120,670
Water Treatment and Purification	$28,312,932
Water Transmission and Distribution	$1,346,357
Total Marginal Cost	**$34,832,629**
Finished Water (MG)	109,674.04
Purchased Water (MG)	179,74
Cost to Product 1 Million Gallons of Water	**$317.08**

Source: MDWASD

Finished water supplied to the distribution system plus purchased water from the cities of Homestead and North Miami Beach was approximately 110,000 million gallons in 2013 resulting in a variable production cost of $317.08 per 1 million gallons of water.

The variable production costs include all the costs for pumping, treatment and chemicals from the treatment plants. In this case, the calculation for 2013 was $317.08 per million gallons. This was calculated using the financial reports, allocating only variable costs to the calculation. The variable production costs did decrease between 2012 and 2013 due to use of inventory of chemicals (purchased in CY 2012 and used in CY 2013).

Table 3-11 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 ($2.92 per CCF)
Variable Production Cost	8	An evaluation of the financial reports calculating only variable costs

4 Water Treatment Plant Losses

The Department operates three regional WTPs: Hialeah, Preston, and Orr; and smaller plants that are part of the South Dade Water System. Table 4-1 summarizes the plant capacities and actual flows. A description of each WTP is provided in the subsections below. The overall annual average daily flow of the entire system is approximately 308 MGD.

Table 4-1 WTP Capacities and Flows

COMPONENT	FACILITY		
	Hialeah/ Preston	Alex Orr	South Dade Water System[1]
Permitted Plant Rated Capacity (MGD)	225.0[2]	256.0[3]	12.3
Actual Flows[4]			
Average Daily (MGD)	141.2	159.2	7.3
Peak Day (MGD)	160.7	180.0	

[1] Represents five smaller WTPs in southern Miami-Dade County.

[2] Hialeah Plant permit capacity is 60 MGD and Preston Plant is 165 MGD for a total of 225 MGD.

[3] Treatment Facility capacity is 256 MGD but the permit is currently limited to 214.74 MGD, based on water allocation.

[4] For Calendar Year 2013

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, Medley which is in stand-by, 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 referenced in Table 4-1 above. Table 4-2 provides a summary of each of the Miami-Dade County permitted Biscayne aquifer wells.

Two new WTPs will provide additional capacity to the water system. The new Hialeah Reverse Osmosis (RO) WTP is owned jointly by the City of Hialeah and MDWASD. The RO plant will have an initial treatment capacity of 10 MGD and it is designed to have an ultimate capacity of 17.5 MGD. It is expected this plant will commence production in the first quarter of 2015. The raw water source for this plant is the brackish Upper Floridan aquifer. The proposed South Miami Heights WTP will replace three of the small treatment plants of the South Dade Water System. This plant will be a 20 MGD membrane softening and RO plant and will have the capacity to treat water from both the Biscayne and Floridan aquifers. This plant is scheduled to go into service in 2015. The Department also has the ability to withdraw water from the Florida aquifer and from Aquifer Storage and Recovery (ASR) wells. Floridan aquifer and ASR wells are listed in the Table 4-3 below.

Table 4-2 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	New SMH WTP	10.00	New Proposed- 5

Source: MDWASD

Table 4-3 Summary of Floridan Aquifer Wellfields

WELLFIELDS	WTP SERVED	DESIGN CAPACITY (MGD)	NUMBER OF WELLS	PERMITTED ALLOCATION (MGY)
Hialeah RO WTP	New Hialeah Plant	24.00	14	8,517
Southwest Wellfield ASR	Alex Orr	10.00	2	1,522
West Wellfield ASR	Alex Orr	15.00	3	2,283
South Miami Heights	New SMH WTP	24.00	7	8,494

Source: MDWASD

The Hialeah and Preston treatment facilities pump into both the high pressure and low pressure systems. The plants are interconnected prior to the high service distribution pumping system and operate a single high service 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 real loss can be accounted for by the handling and disposal of residuals. As previously indicated lime softening is the primary treatment of the groundwater at the three regional treatment facilities. 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.

The Hialeah WTP also includes a lime recalcination facility. This facility is a rotary kiln-natural gas fired type facility. Dewatered lime is then recycled through the process of recalcination. The lime kiln burns $CaCO_3$ and produces up to 100-115 tons per day of calcium oxide (CaO) which is then slaked and returned for reuse in the lime softening process. The plant also treats the residuals generated at the Preston WTP from accelator units 1, 2, and 3. The released carbon dioxide (CO_2) is captured and used in the recarbonation process at the plant. The airvayor system is used to pneumatically transfer lime from the lime storage silos at the recalcination plant back to lime feed silo at the lime slurry feed plant.

At the Alexander Orr plant, fifty percent of the residuals generated in the lime softening process are stored and processed through a lime recalcination facility similar to the one at the Hialeah plant. Any excess calcium carbonate from the treatment processes is sent to the sludge holding cells at the Southwest wellfield or the cells at the Orr plant..

Prior to recalcination, 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 recalcination 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 and Hialeah/Preston WTPs. Although large quantities of water are used in the process for backwashing filters, feeding chemicals, etc., the great 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.

4.1.1 Raw Water Flows

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

4.1.1.1 Alex Orr Water Treatment Plant

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

Table 4-4 Alex Orr WTP Raw Water Flows

MONTH	SUM OF INDIVIDUAL WELL FLOWS	RAW WATER PLANT FLOWS	VOLUME DIFFERENCE	PERCENT DIFFERENCE
January	5,578	5,263	315	6%
February	5,099	4,794	305	6%
March	5,376	5,062	314	6%
April	5,287	4,991	296	6%
May	5,300	4,999	302	6%
June	5,090	4,863	227	5%
July	5,553	5,214	339	7%
August	5,421	5,113	309	6%
September	4,601	4,295	306	7%
October	4,713	4,348	365	8%
November	5,266	4,934	332	7%
December	5,463	5,158	306	6%
CY 2013 Avg	**5,229**	**4,919**	**310**	**6%**

Source: MDWASD

At the Orr WTP the sum of the individual wells raw water flows registered on average 6 percent higher than measured at the plant raw water influent venturi meters. This is a reflection of both under/over registration and meter accuracies given that these totals reflect the sum of 38 individual meters- 34 remote well meters and 4 raw water venturi meters at the plant.

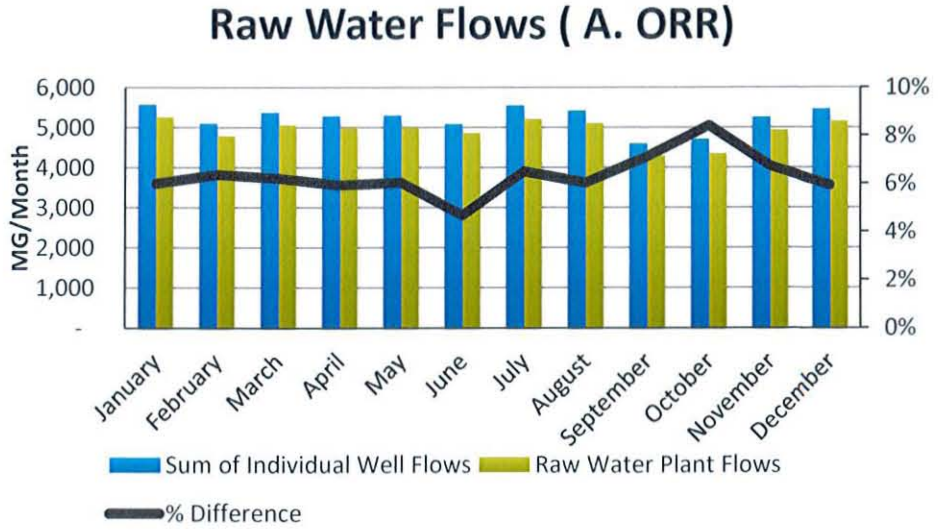


Figure 4-1 Alex Orr WTP Raw Water Flows

4.1.1.2 Hialeah and John Preston Water Treatment Plants

The Hialeah and Preston plants receive a combination of the flows coming from the Northwest and Miami Springs (Upper and Lower) wellfields in addition to the wellfields located within the plant sites. The Preston plant receives primarily flows from the Northwest wellfield but it also receives a portion of the flows from the Miami Springs upper wellfield. The Hialeah plant receives mostly flows from the Miami Spring wellfields but also receives a portion of flows from the Northwest wellfield.

Tables 4-5 and Figure 4-2 below compare the raw water flows (Million Gallons) metered at the well fields and the raw water flows metered at the Hialeah and Preston plants combined

Table 4-5 Hialeah & Preston WTPs Combined Raw Water Flows

MONTH	SUM OF INDIVIDUAL WELL FLOWS	RAW WATER PLANT FLOWS	VOLUME DIFFERENCE	PERCENT DIFFERENCE
January	4,184	4,400	(216)	-4.9%
February	4,000	3,965	35	0.88%
March	4,545	4,801	(257)	-5.35%
April	4,509	4,470	39	0.87%
May	4,764	4,739	25	0.53%
June	4,321	4,513	(192)	-4.25%
July	4,085	4,038	47	1.16%
August	4,484	4,382	102	2.33%
September	4,731	4,664	67	1.44%
October	4,846	4,855	(9)	0.19%
November	4,088	4,054	34	0.84%
December	3,981	3,947	35	0.89%
CY 2013 Avg	**4,378**	**4,402**	**(24)**	**-0.55%**

Source: MDWASD

The Hialeah/Preston combined sum of the individual wells raw water flows reflects both under/over registration throughout the year. However when looking at the total raw water pumped in CY2013 from the wells and raw water entering the plants, the difference is 0.55%. The monthly under/over registration of these totals reflect inherent meter inaccuracies given that these reflect the sum of 50 individual meters- 45 remote well meters and 5 raw water venturi meters at the two plants

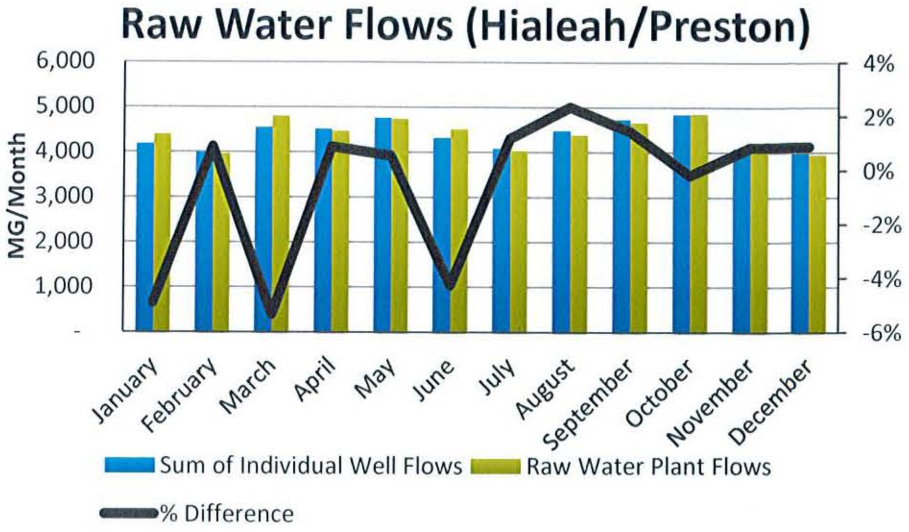


Figure 4-2 Hialeah/Preston Combined Raw Water Flows

4.1.2 Treated Water Flows

4.1.2.1 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 than the metered treated water at the Preston Plant.

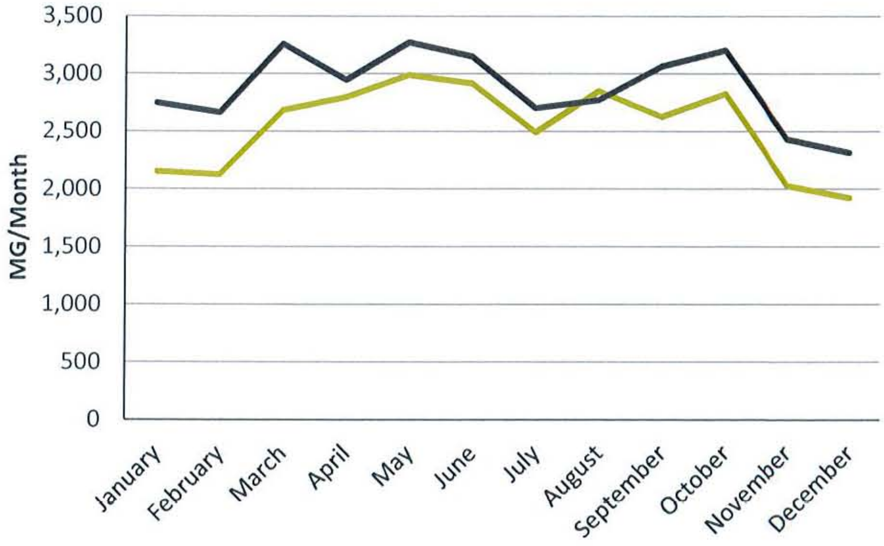


Figure 4-3 Preston WTP Difference between Treated and Raw Water Flows

Figure 4-4 indicates that the raw water influent flow was on average 16% lower than the treated water flow metered at the Hialeah Plant.

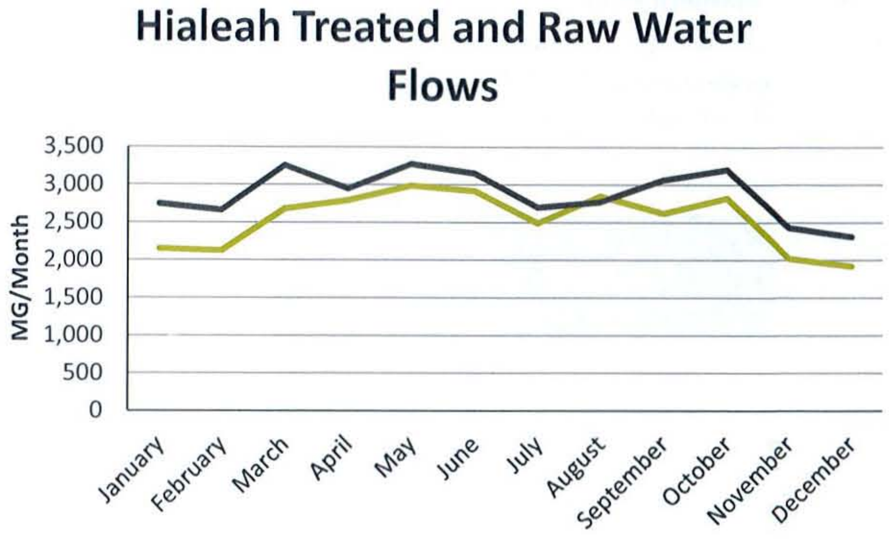


Figure 4-4 Hialeah WTP Difference between Treated and Raw Water Flows

When these two plant flows are combined and added up, the results indicate that, on average, there is less than 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 year 2012.

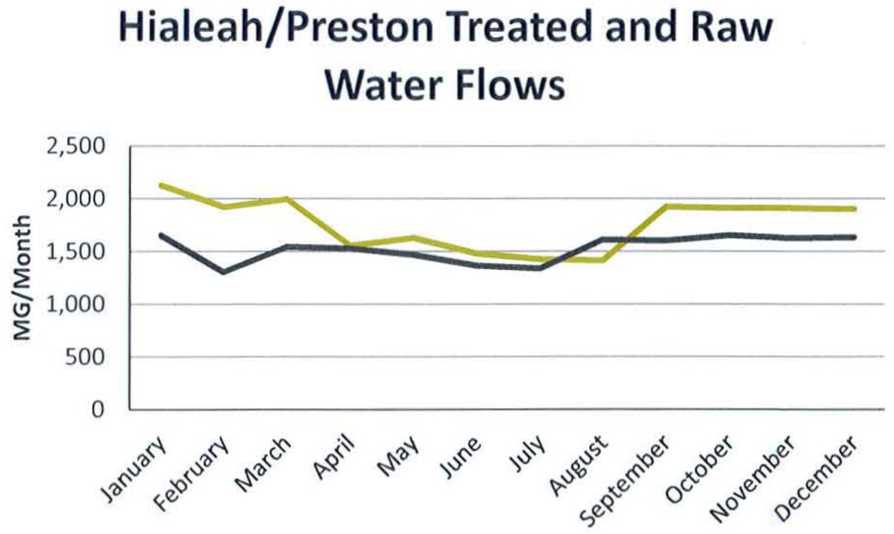


Figure 4-5 Hialeah/Preston WTPs Combined Difference between Treated and Raw Water Flows

The differences in the metered flows for each individual plant reflect the fact that they need to be combined given the hydraulics between the two plants. The Preston plant feeds treated water to the finished water clearwell at the Hialeah plant. This inter plant flow is not measured but explains the underegistration of treated water flows metered at Preston and over registration of treated water flows metered at the Hialeah plant.

4.1.2.2 Alexander Orr Water Treatment Plant

Table 4-6 below indicate that the raw water flows measured at the Orr plant were on average 1.5% higher than the treated water flows metered at the plant. This represents a water loss of less than two percent through the plant, and well within expected typical losses.

Table 4-6 Orr WTP Treated vs. Raw Water Flows

2013	TOTAL RAW WATER (MGD)	TOTAL FINISHED WATER (MGD)	DIFFERENCE (FINISHED LESS RAW)	% DIFFERENCE
January	5,185	5,263	(78)	-1.47%
February	4,724	4,794	(70)	-1.46%
March	4,984	5,062	(78)	-1.53%
April	4,916	4,991	(75)	-1.50%
May	4,921	4,999	(78)	-1.55%
June	4,788	4,863	(75)	-1.54%
July	5,136	5,214	(78)	-1.49%
August	5,035	5,113	(78)	-1.52%
September	4,220	4,295	(75)	-1.75%
October	4,270	4,348	(78)	-1.78%
November	4,859	4,934	(75)	-1.52%
December	5,080	5,158	(78)	-1.50%

Source: MDWASD

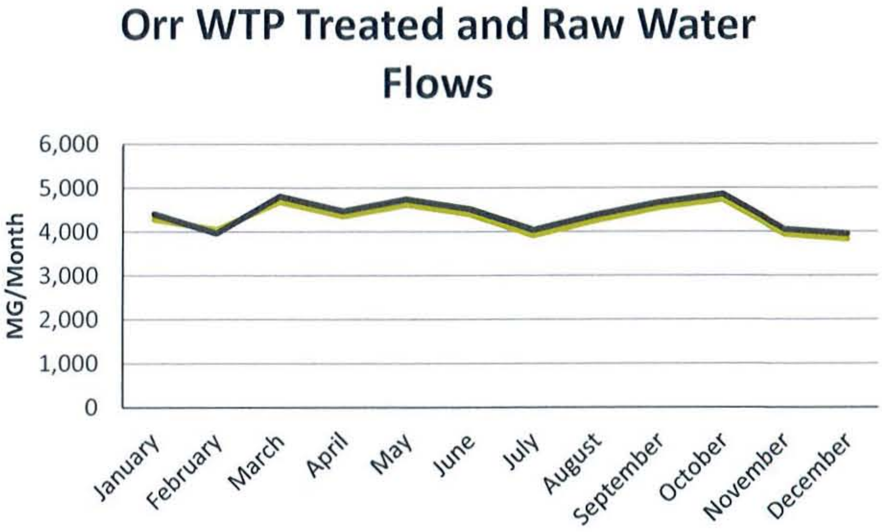


Figure 4-6 Orr WTP Difference between Treated and Raw Water Flows

4.1.3 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. Additional work is anticipated to be completed in 2014.

4.1.3.1 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).

4.1.3.2 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. This is due to be assessed in 2014.

4.1.3.3 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 include 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 CCMWA SOP's and policies.

4.1.3.4 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.

4.1.4 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.

Table 4-7 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%

Source: MDWASD

Table 4-4 above shows the results of the calibration for both CY 2013 and CY 2012.

4.1.5 Conclusions

Hialeah/Preston WTPs

Combined flows indicate- shown in Figure 4-5 above- that, on average, there is less than a three percent water loss through the Hialeah/Preston treatment complex. This is consistent with the results reported for calendar year 2012 for the combined plants. This volume of loss is more commensurate with typical water losses through conventional treatment plants.

Raw water flow through a booster pump station installed in 2004 at the Preston WTP is not currently accounted for at the raw water Venturi meters at the Hialeah/Preston WTPs. It is recommended that MDWASD take actions to remedy this, which will allow for more accurate estimates of the raw and finished water losses to be estimated for subsequent years.

5 Results

Performance indicators are an important measurement tool, to make sure that the utility is keeping on track (with respect to its operational practices and to reduce any water losses) both internally and in comparison to its peers. The new standard methodology fundamentally breaks down each major aspect of water losses and uses into specific categories. This breakdown then allows for more detailed and accurate reporting, and more accurate targeting of the volume and cost of losses, thereby allowing targeting of resources to the areas most in need.

MDWASD appears to have reasonable performance as determined and recorded in Table 11 below. 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. Benchmark data is under development by AWWA, against which the data and results can be directly compared to in the future.

Table 5-1 Performance Indicators FY 2013

INDICATOR	VALUE	UNITS
Validation Grading	77	out of 100
Non-revenue water as percent by volume of Water Supplied:	26.7%	%
Apparent Losses per service connection per day:	22.16	Gallons per connection per day
Real Losses per service connection per day:	112.51	Gallons per connection per day
Infrastructure Leakage Index	9.21	Dimensionless
Annual Cost of Apparent losses	$10,235,199	$
Annual Cost of Real Losses	$5,843,306	$

5.1 REAL WATER LOSS GOALS

MDWASD's Real loss performance indicators included the real loss in gallons per service connection of approximately 113, and Infrastructure Leakage Index (ILI) which is estimated to be approximately 9.2 in 2013. 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 values for miles, number of connections, and pressure increases, the UARL will increase. More details regarding calculation of the ILI can be found in AWWA manual M36 (third edition, 2009) 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

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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.

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

5.2 APPARENT WATER LOSS GOAL

Apparent loss is water that is being used but for which the utility receives no compensation. Reducing apparent loss does not reduce water use, but does enhance utility revenue. Estimated apparent losses are approximately 22 gallons/connection/day. Based on the AWWA National Water Audit Data Initiative (WADI) data from 2010 to 2012, the average utility reported apparent loss of approximately 10 gallons/connection/day.

With respect to apparent losses, such as meter and billing inaccuracies, a target of 10 gallons/connection/day for apparent losses has been used in this analysis. It is theoretically possible to reduce apparent losses to zero, but this will not be possible due to the size and complexity of the MDWASD 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 reduction programs in the near future, if additional funds for these programs are not immediately available.

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 Recommendations

There are many on-going activities which MDWASD 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 2013.

1. Continue with the dual main replacement project. The replacement of the old galvanized service lines will have a significant effect on reducing water loss in the distribution system.
2. Continue with the automated leak noise logger trials and develop a cost-benefit analysis for expansion of any preferred system.
3. The Miami Springs pilot zone should be set up. This is one unit of the distribution system that is ready made for a district analysis (one supply pipe with existing metered connection). MDWASD is planning on commencing this work during CY 2014. This work encompasses the the following goals
    a. To comparatively analyze the effectiveness of a ground survey (ground microphones and correlators versus the data logging systems)
    b. Evaluate the data availability from the currently installed AMR system and use this data to perform a water loss analysis in the pilot zone.
    c. Theoretically analyze the effectiveness of pressure management.

The true picture of what is physically lost out of the system will only be truly known after field validation of water losses through measurements such as district metered areas. In the short to medium-term the knowledge 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).

The WUP highlights areas for implementation (see Appendix C). In addition the initial review of the Audit Software results highlighted the following as possible issues

I. Validity of data – a number of the data evaluations were estimates which need additional work to prove and validate. Improvements were made in CY2013, but additional work still needs to be done.

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

III. 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-inch meters initiated.

IV. Billing system accuracy – the relatively large water loss component means that evaluation of customer accounts to reduce apparent loss error from mis-classified or missing accounts is advisable.

6.1 RECOMMENDED BEST PRACTICE IMPROVEMENTS

Recommended items for best practice improvement include;

Validity of Data

1. Conduct discussions with the relevant staff for each of the priority items. Re-evaluate data from multiple years and remove or understand anomalies
2. Continue to evaluate calibration data and testing data for production/finished water meters on an annual basis. Conduct flow volume to complement the electronic calibration. Estimate the master meter error adjustment. (Also see meter accuracy section for retail meter data validity)
3. Continue to conduct the audit on an annual cycle. Continue discussions with the working group to analyze and assess water losses, and to create accountability for data.

Reduce Leakage

1. Continue with the evaluation of manual and automated (leak noise logger) survey methods to improve active leakage control.
2. Construct pilot district metered area(s) in one or more selected portions of the system. Analyze actual leakage for the(se) specific system sectors and determine the costs, benefits and complexities of expanding 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.
5. Conduct a review of staffing levels and equipment that may be required for proper implementation of recommendations.

Meter Accuracy

1. Conduct testing of a selection of retail meters of 1-inch, 1.5-inch and 2-inch sizes to complement the work on the 5/8-inch and 3-inch and larger meters that were conducted in 2012. Continue to test meters of all sizes and manufacturers throughout the following years. Record the average inaccuracy, weight the average depending on the volume through each meter size, and record in the audit for CY 2014 year.
2. Test the wholesale customer meters twice a year. Determine if there are any inaccuracies and record this in the overall audit.
3. Analyze master meter testing results every year, and note and calculate on the audit the discrepancies.

Billing System Accuracy

1. Conduct detailed review of billing system operations, including
   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 assessment to make sure that there are no errors in accounting of data, or from meter readings to the billing system.

Some of the main 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

Prioritisation of Implementation Programs

Each of the programs described above and in the outlines below will provide some measure of aid to reducing the volume of water loss and/or reduce the revenue impact of those losses. As would be expected some will have a faster return on investment. As the analyses are developed and data further validated the level to which the losses can be reduced will be better understood. The analysis of existing leakage data is aiding with prioritization, but development of the district metered area 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 normal ground 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. This is improving knowledge of 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.

6.1.1 Validity of Data - Improving Validation

Improvements in validation could include annual review of data and more discussion regarding the scoring of the accuracy of data. The performance indicators developed above 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 performance indicators. 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 must be 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. The data set could be divided among team members in a similar format with the performance indicators. 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.

6.1.1.1 Continue Annual Water Audit

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. 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.

Once performance trends are established, a staff member should be assigned to review and control the data. In many cases the most efficient method is to have a Management Analyst working full-time on this analysis. This work almost always pays for itself with the revenue enhancements and savings that this individual can find and help to manage reduction.

6.1.2 Reduce Leakage

General Department response and action with respect to water main breaks is equal to or above industry averages. There are some areas of possible improvement available in all three components of reported leakage: awareness, location, and repair.

The Department currently has an excellent active leakage control program, and this program should improve with the addition of extra staff. With respect to unreported leaks, the Department can improve by reducing the time to survey the system. However, there are significant constraints beyond the control of MDWASD which hamper this effort. These include the line location company time requirements which are set and fixed timelines. Once more detailed analysis of the costs and benefits of the leak detection program is performed; the actual reduction in water losses can be estimated. If the real losses are still greater than the ILI goal, then additional resources could be targeted to reduce the survey cycle further or otherwise 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. Electrical transformers, street lights, pumping equipment and pipeline bends and constrictions can all cause noise signatures which can confuse the noise logging units. Therefore a component of this program should also include field staff conducting acoustic surveys with ground microphones, and listening to all the hydrants, valves, and fittings in targeted areas. Remote technology is an excellent tool, but it does not yet act as a total replacement for active surveys. Performance indicators showing the number of leaks, types of leaks, and identification method should be recorded and reported.

The current dual main replacement program will also aid the reduction of leakage as the old galvanized service lines in alleyways are known to be a major source of leakage wherever they are still part of the infrastructure mix. Also, hot-spot areas with unusually large leakage should be identified and measured through active surveys, and targeting methods such as District Metered Areas (DMA). This would allow better targeting of resources to the most problematic areas.

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

6.1.2.1 District Zone Active Leak Detection

Active leak detection should include the development of a DMA to improve the knowledge of actual amount of water loss in a pilot zone. This subsection also describes an overview of an active leak detection processes which could be used for the Department.

6.1.2.2 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 an assessment of 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 (MNF) usually occurs between 02:00 AM and 04:00 AM each morning, and is one of the most meaningful pieces of data for measuring leakage. However, in the Department-specific case, there will be sectors within the distribution system where the minimum flow rate does not occur during this period. Those areas with newer homes, which have automatic sprinkler systems, can change the water use characteristics considerably. Automatic sprinklers are often set between 2 AM and 4 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 were days within the week where no irrigation was allowed, then it would be possible to continue with this practice during the rest of the year.

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.

6.1.2.3 Acoustic Leak Detection

The goal of district metering is to identify excess flows, and quantify reduction in water losses. The Department has excellent acoustic leak detection procedures. Acoustic leak detection surveys are needed to actually pinpoint unreported leaks by detecting leak noise. Leak "noise" simply refers to a hum (or hiss) caused by vibrations created on pipes, when pressurized water escapes through a crack or pinhole. Vibrations can also transfer onto pipes from traffic, other underground infrastructure, etc., but noises heard on fittings such as hydrants or valves alert technicians to possible leaks. Sophisticated computers (leak noise correlators) can be used to pinpoint the source of the vibration along the pipe. Acoustic leak detection surveys therefore describe technicians listening to hydrants and/or valves within the system.

Traffic, other underground utilities, and customer usage can also transfer vibrations onto water mains and services. These vibrations can mask leak noise as well as be misinterpreted. Correlating noise loggers offer the distinct advantage of being deployed during the day, but programmed to listen for leak noise overnight during periods when traffic and customer usage may be minimal.

6.1.2.4 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.

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

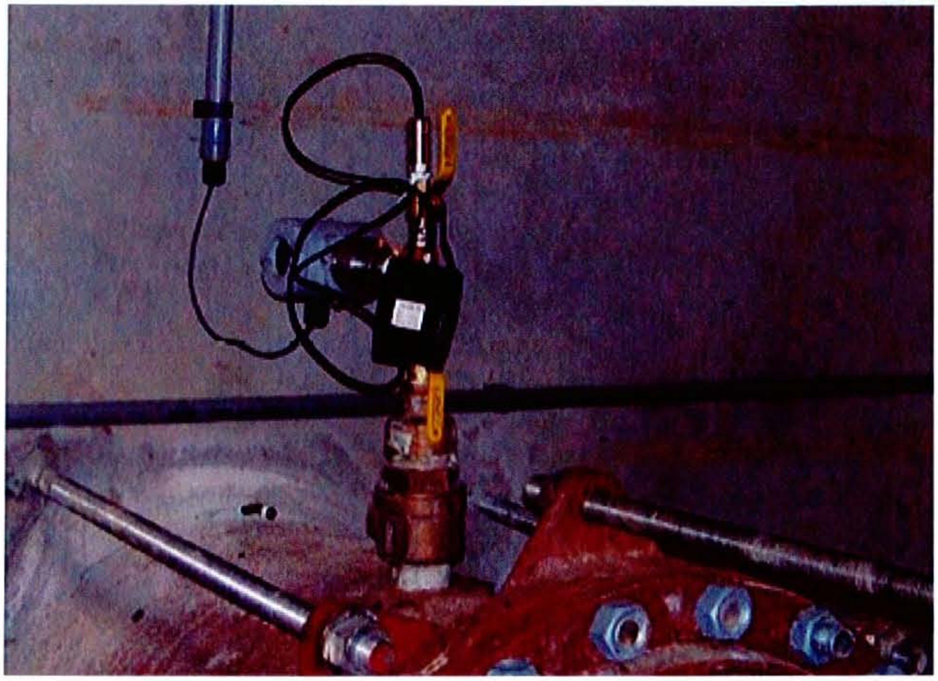

Figure 6-1 Example Pressure Logger Installation

6.1.2.5 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 trained leak-locating crews. The limiting factor associated with faster repair times may be associated with obtaining timely utility locates. By improving other utility (gas, electric Department, etc.) location times, repairs can be completed in a more timely manner.

6.1.3 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 at the time of this project. Improvement in this area will not reduce the amount of water delivered, but will significantly increase revenues from previously under-performing meters. 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.

6.1.3.1 Volume Limits

A sample of residential meters with throughput volumes which are above the warranty limits (Table 10) for repaired meters should be tested. It is expected that there are a number of 2-, 1.5-, 1-, and $^5/_8$-inch meters with flow volumes in excess of the warranty limits. The 5/8-inch meters are already being tested as part of an ongoing program initiated in 2012 and age analysis was conducted in 2013. This needs to also be expanded to the larger meters.

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 allow this to be determined.

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 [see AWWA manuals M22 and M6 for more information] determines the best meter size for the customer). In addition, improvements in meter accuracy will improve revenue recovery from sewer usage charges. These need to be reviewed within this strategy.

6.1.3.2 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 ages of replacement up to 25 years (depending also 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 of 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. One part of this analysis has been initiated by staff interns in 2013 and this data will continue to be analayzed and improved upon in subsequent years. The structured approach evaluating volume, variations in high, intermediate, and low flow, as well as age and meter sizing is recommended.

6.1.3.3 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 this 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.

6.1.3.4 Conduct Assessment of AMR Implementation

Conduct an evaluation of the costs and benefits of the current AMR program, review expected timelines and costs for future maintenance and/or replacement. Currently the staff costs for billing are very low, and 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 benefits, and recommend the most advantageous program.

6.1.4 Billing System Accuracy

The Department has dedicated staff and put 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 billing system accuracy on other bills.

6.1.4.1 Review Unauthorized Uses

Conduct an analysis of theft of service, and customers not currently receiving the correct bill. This needs to be in conjunction with a billing analysis. Initial review would include analysis of customers with water service but no wastewater service, accounts that consistently read zero, identification of addresses with no service, etc.

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[4] The large meter testing flow rates are being changed in the newest version of AWWA Manual M6 (Due December 2010). See this manual for more detailed testing information.

6.1.4.2 Evaluate Mis-classified Accounts

Evaluate and correct accounts with mis-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 mis-classified accounts would need to be determined and changed.

6.1.4.3 Water Billing Data Quality Control

Although the Department has staff specifically dedicated to billing process and read exception analyses, additional resources would enhance the progress. Existing staff have other billing related tasks. Under this strategy, the Department would dedicate a full-time Management Analyst to oversee the water loss reduction and revenue enhancement program. Improvements 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 is 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:

- 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.
- Review customer accounts with a water account, but no wastewater account.
- Review fireline 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. Somewhere in between will be the economic level for the utility to maintain. The economic level of losses is usually described as follows: when the savings from the recovered water exactly offset the expenditure to save the water. However, 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. 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 Plan.

Appendix A—Implementation Plan

Limiting condition No. 49 of the the Department's Water Use Permit No. RE-ISSUE 13-00017-W of 16 July, 2012, requires the Department to report on the status of activities listed in the approved water loss reduction plan further identified in Exhibits 17A and 17B of the permit.

Below are listed all the activities listed in Exhibits 17A and 17B. Each item is further described in the following sections.

Appendix A - Table of Contents

Conduct Field Accuracy Testing of Commercial Meters

Pilot AMR to Improve Data and Reduce Cost

Characterize Residential Water Demand Use Pattern

Determine Economic Optimum for Residential Meter Replacement

A.5.3.1 – SYSTEM DESIGN (5.3.1 IN WATER USE PERMIT)

History

Completed

Recommended Follow-up Activities

None

A.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, MDWASD 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 betterment investments with economic impact assessment of leak incidences.

In 2010, MDWASD also initiated the "Condition Assessment of Prestressed Concrete Cylinder Pipe (PCCP)" program which surveyed the major water transmission pipelines. As a result of the assessment, MDWASD developed a rehabilitation program using Carbon Fiber Reinforced Plastic (CFRP) system and over 40 miles of PCCP were inspected in 2011.

In 2012 the Department completed inspection of all 120 miles of large diameter PCCP pipe in the water distribution system and successfully repaired/replaced 118 segments.

3. Conducted in Audit year (CY2013)

In 2013 the Department has updated 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.

Recommended Follow-up Activities

- Implement the modified approach for pipe replacement as recommended by the study.
- 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 through evaluation through field testing. Continue the PCCP rehabilitation program, as recommended in the assessment.
- Follow up on the recommendations of this study in order to conduct pipeline condition assessment on those segments of the distribution system found critical.

A.5.3.2.4 – REDUCE MAINTENANCE RESPONSE TIMES

MDWASD initiated efforts to reduce the time it takes for its maintenance crews to respond to leaks and to improve the speed and quality of its repairs.

History

MDWASD has kept basic data on speed and quality of repair for many years, however, until recently it has not generally 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.

Conducted in Audit year (CY2013)

In 2013 MDWASD 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 repatches).

Recommended Follow-up Activities

- Construct an active database of the times that leaks were reported, pinpointed and repaired. The costs of repair (labor and materials) should also be included an the amount of lost water estimated when this data is available. This data should be used to determine the costs of each leak and cost-benefit of avoiding these costs developed.
- Evaluate awareness times in cases where known issues have run for extended periods of time (but were not associated to leakage until after a leak was found).
- 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.
- Conduct a review of staffing levels and equipment that may be required for implementing recommendations

A.5.3.2.5 – ACTIVE LEAKAGE CONTROL AND SOUNDING

MDWASD initiated an active leakage control and sounding program, including both unmanned (noise logger) and manned leak surveys.

History

In 2010, MDWASD 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, investments, and economic levels of return. The study proposed a modified approach to align system betterment investments with economic impact assessment of leak incidences.

MDWASD is also 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 repatches).

Conducted in Audit year (CY2013)

In 2013 MDWASD initiated an evaluation of automated leakage detection through leak noise loggers. Two systems were trialed (the trials are continuing into 2014) and evaluations of success compared with leaks detected and repaired are being conducted. MDWASD has also increased the sensitivity of its leak detection program by reducing the distance between noise loggers (both automated and manually deployed) and reducing the length of main surveyed at one time by leak detection crews, thereby reducing leak duration by reducing the time between leak initiation and detection.

Mapping was conducted to determine the location of leaks within the system. This was transfered onto GIS and leak "hot spot" maps developed. Currently the data is shown by leaks per square mile.

Recommended Follow-up Activities

- Implement the modified approach for leak detection as recommended by the study.
- Continue with automated leakage detection trials of leak noise loggers.
- While collecting leak detection 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/causes of leak.
- Monitor and review leaks and stressed pipes within the network.
- 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.
- Evaluate the effectiveness of acoustic leak noise logger surveys versus standard ground surveys conducted by Leakage Technicians.

A.5.3.2.7 – PRESSURE MANAGEMENT

As part of this, MDWASD plans to complete a Zone Management Pilot.

History

MDWASD 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.

Conducted in Audit year (CY2013)

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.

Recommended Follow-up Activities

- Continue with the development of the pilot study.
- Assess the effectiveness of pressure management within Miami Springs

A.5.3.2.8—SPEED AND QUALITY OF REPAIRS

MDWASD initiated efforts to improve the speed and quality of its repairs.

History

MDWASD has kept basic data on speed and quality of repair for many years, however, until recently it has not generally 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.

The MDWASD has 10 crews dedicated to fix any leaks as soon as possible including night-shift teams.

Conducted in Audit year (CY2013)

In 2013 MDWASD 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 repatches).

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.

ENHANCE GIS DATABASE

MDWASD is currently enhancing its GIS database.

History

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

Conducted in Audit year (CY2013)

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.

Recommended Follow-up Activities

Plan integrated use of expanded capabilities in asset management program.

RECOMMENDATIONS FOR APPARENT LOSS REDUCTION

A.6.3.1 – REDUCING UNMETERED SUPPLIES

MDWASD continues with efforts to reduce unmetered water supplies.

History

Fire-fighting and main flushing are the largest unmetered uses in MDWASD'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 MDWASD were identified and contacted to request their cooperation in developing a methodology to better account for their water usage.

Conducted in Audit year (CY2013)

In 2013 main flushing continued to be monitored actively and flow x duration calculations developed. Fire department water use was not accounted for.

Recommended Follow-up Activities

- Conduct meetings with the identified 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.

A.6.3.2 – IMPROVED (RETAIL) METER ACCURACY

MDWASD continues to conduct field accuracy testing of commercial meters to improve 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-inch meters. In 2012, two new technologies (ultra sound and electromagnetic meters) continue to be tested. In 2012 a residential meter testing program was initiated. More than 800 meters were tested in 2012.

Conducted in Audit year (CY2013)

In 2013 MDWASD 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 are being trialled.

Recommended Follow-up Activities

- Perform recurring testing of commercial meters to cover entire inventory over time. Determine testing frequency by meter size and configuration based on economical and statistical analyses of commercial meter samples.

- Install test taps at locations that have been evaluated and inspected where displacement meters 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

A.6.3.3.2.1 – COMPOUND METER USAGE COMPARED TO SAME SIZE TURBINE METERS

MDWASD initiated efforts to compare compound meter usage to similarly-sized turbine meter settings.

History

MDWASD has obtained a few new style "Omni" meters from Sensus for evaluation. These meters act as compound meters and were installed by MDWASD 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 MDWASD.

Conducted in Audit year (CY2013)

In 2013 MDWASD continued to use and specify the Omni meters. Continued analysis has been conducted to prove out the satisfactory results developed in previous years.

Recommended Follow-up Activities

- Continue to document the initial evaluation of "Omni" meters.
- Develop and analyze a data base with testing data results.
- Continue replacing the obsolete turbine meters with "Omni" or other reliable meters currently under evaluation by MDWASD.
- Test the turbine meters to determine the meter accuracy and to rank replacements

A.6.3.3.3 – LOOKING FORWARD (SETTING ECONOMIC METER TESTING GOAL)

History

Completed

Recommended Follow-up Activities

None

A.6.3.4 – IMPROVED CALIBRATION OF WHOLESALE CUSTOMER METERS

MDWASD is currently performing comparative accuracy testing on its wholesale customer venturi, turbine, and positive displacement meters.

History

MDWASD 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.

Conducted in Audit year (CY2013)

The wholesale customer meters continue to be tested twice per year.

Recommended Follow-up Activities

- Plan Capital Improvement Program required for testing inaccessible meters.
- Continue to conduct semi-annual testing of wholesale meters

A.6.3.5 – WHOLESALE CUSTOMER UNMETERED CONNECTION ANALYSIS

MDWASD initiated unmetered wholesale customer connection survey and analysis.

History

In 2009, MDWASD found a wholesale meter by-pass that was open allowing unmetered water delivery to the wholesale customer. All by-pass meters have now been locked and evaluation of metering or connection to SCADA will be undertaken in 2011.

Conducted in Audit year (CY2013)

In 2013 MDWASD continued to check the by-pass meters to make sure they continue to be locked and no tampering had been conducted.

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.
- Consider installing bypass meters on any unmetered line

PERFORM VENTURI COMPARATIVE TESTS - WTPS

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

History

In 2012 MDWASD;

- Contracted with GE Measurement and Control to conduct flow diagnostics of all the magnetic flow meters currently installed at all the supply wells in the system. The test results presented in the June 3, 2012 report titled "Well Water Flow Meter Verification Report" showed that all the 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 the 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.

Conducted in Audit year (CY2013)

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.

Recommended Follow-up Activities

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

PERFORM COMPARATIVE TESTS – WHOLESALE CUSTOMERS

MDWASD continues to perform comparative accuracy testing on its wholesale customer venturi, turbine, and positive displacement meters.

History

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

Conducted in Audit year (CY2013)

Wholesale customer meters continue to be flow tested annually where possible.

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

PILOT FIXED NETWORK

MDWASD is currently expanding the AMR/AMI network.

History

In 2010, MDWASD initiated the expansion of the AMI network with the installation of additional AMI meters from Sensus Metering Systems, Inc. A total of 820 AMI meters were installed in the MDWASD service area and 4,300 AMR meters in the Miami Springs service area have been installed.

MDWASD also worked on a joint AMI project with the Parks department.

Conducted in Audit year (CY2013)

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, but will go live for billing purposes in 2014.

Recommended Follow-up Activities

Continue to expand AMR/AMI network and continue to test its effectiveness in the MDWASD service area.

DETERMINE ECONOMIC OPTIMUM FOR RESIDENTIAL METER REPLACEMENT

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

History

"Meter Master" loggers were deployed to characterize residential demand in October 2008 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.

Sensus SR model meter is an old meter design that comprises most of the MDWASD's meter inventory. In 2010, MDWASD investigated different meter models and began to consider new meters such as Sensus "iPERL".

In 2011, MDWASD started the implementation of 4,000+ "iPERL" meters.

In 2012 a residential meter testing program was initiated. More than 800 meters were tested in 2012. Review of the meter shop operations and practices was also conducted to improve efficiency of replacement understanding and procedures.

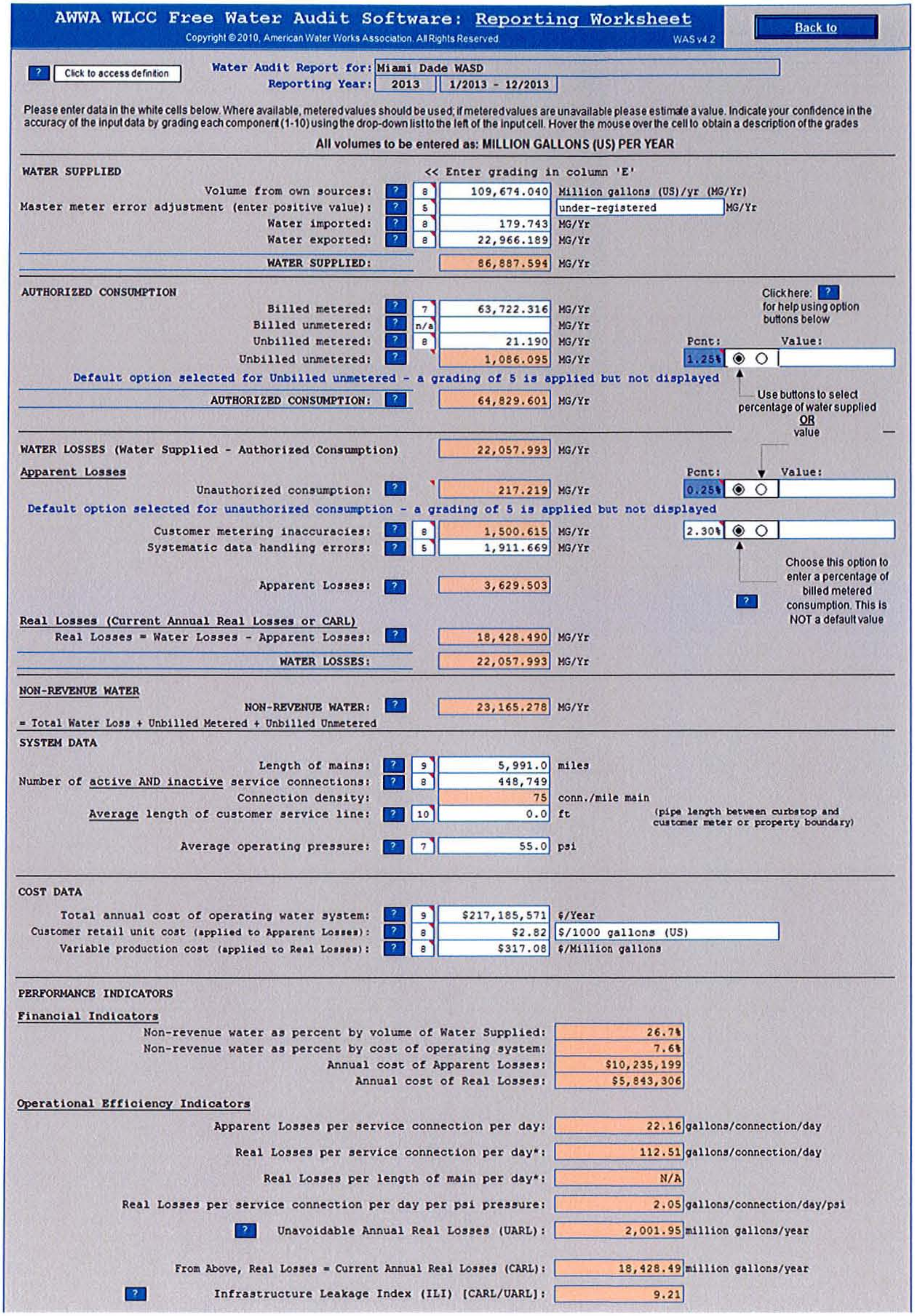
Conducted in Audit year (CY2013)

Analysis of the degradation of the retail customer meters was evaluated in 2013 to initiate more active replacement policies for these meters within the MDWASD system. Review of the lead-free requirements of Section 1417 of the Safe Drinking water Act was conducted to assess how it may affect the repair and replacement of the existing meter stock.

Recommended Follow-up Activities

- 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



AWWA WLCC Free Water Audit Software: Reporting Worksheet

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Water Audit Report for: Miami Dade WASD
Reporting Year: 2013 | 1/2013 - 12/2013

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 (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

WATER SUPPLIED << Enter grading in column 'E'

Volume from own sources:	8	109,674.040	Million gallons (US)/yr (MG/Yr)
Master meter error adjustment (enter positive value):	5		under-registered MG/Yr
Water imported:	8	179.743	MG/Yr
Water exported:	8	22,966.189	MG/Yr
WATER SUPPLIED:		86,887.594	MG/Yr

AUTHORIZED CONSUMPTION

				Pcnt:		Value:
Billed metered:	7	63,722.316	MG/Yr			
Billed unmetered:	n/a		MG/Yr			
Unbilled metered:	8	21.190	MG/Yr			
Unbilled unmetered:		1,086.095	MG/Yr	1.25%	● ○	

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

AUTHORIZED CONSUMPTION:	64,829.601	MG/Yr

WATER LOSSES (Water Supplied - Authorized Consumption)	22,057.993	MG/Yr

Apparent Losses

				Pcnt:		Value:
Unauthorized consumption:		217.219	MG/Yr	0.25%	● ○	

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

Customer metering inaccuracies:	8	1,500.615	MG/Yr	2.30%	● ○	
Systematic data handling errors:	5	1,911.669	MG/Yr			
Apparent Losses:		3,629.503				

Real Losses (Current Annual Real Losses or CARL)

Real Losses = Water Losses - Apparent Losses:	18,428.490	MG/Yr
WATER LOSSES:	22,057.993	MG/Yr

NON-REVENUE WATER

NON-REVENUE WATER:	23,165.278	MG/Yr

= Total Water Loss + Unbilled Metered + Unbilled Unmetered

SYSTEM DATA

Length of mains:	9	5,991.0	miles
Number of active AND inactive service connections:	8	448,749	
Connection density:		75	conn./mile main
Average length of customer service line:	10	0.0	ft (pipe length between curbstop and customer meter or property boundary)
Average operating pressure:	7	55.0	psi

COST DATA

Total annual cost of operating water system:	9	$217,185,571	$/Year
Customer retail unit cost (applied to Apparent Losses):	8	$2.82	$/1000 gallons (US)
Variable production cost (applied to Real Losses):	8	$317.08	$/Million gallons

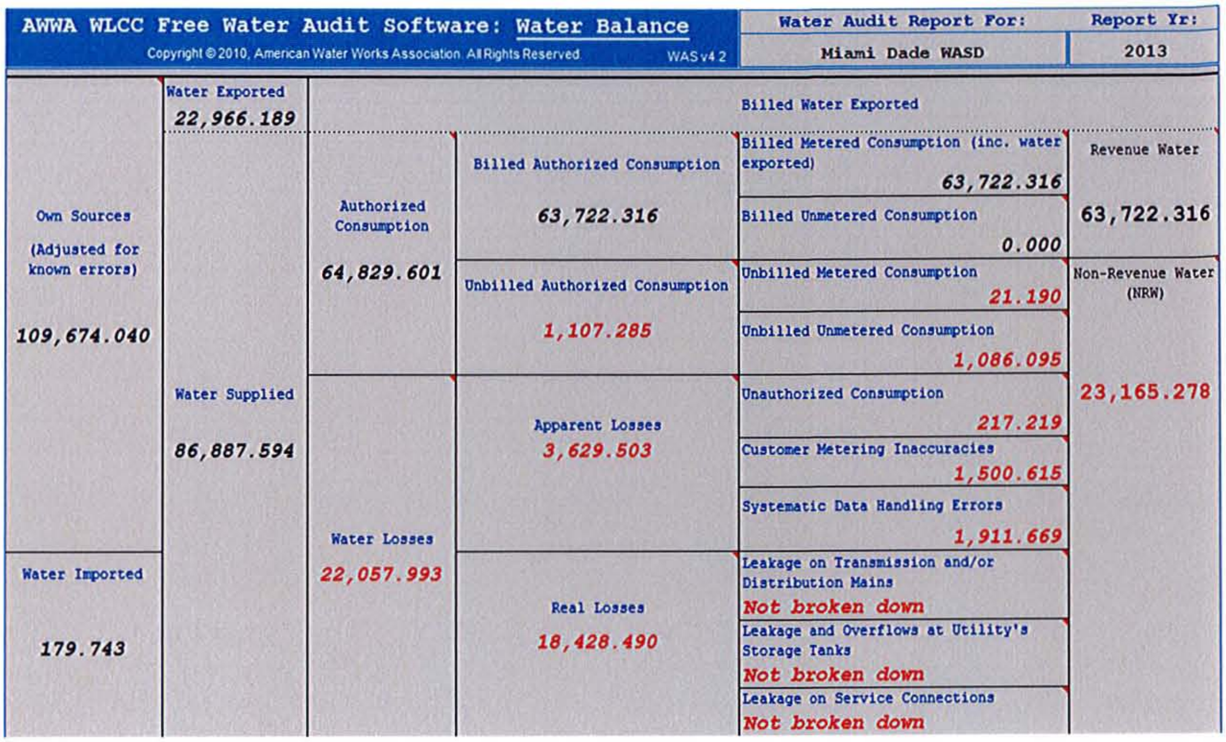
PERFORMANCE INDICATORS

Financial Indicators

Non-revenue water as percent by volume of Water Supplied:	26.7%	
Non-revenue water as percent by cost of operating system:	7.6%	
Annual cost of Apparent Losses:	$10,235,199	
Annual cost of Real Losses:	$5,843,306	

Operational Efficiency Indicators

Apparent Losses per service connection per day:	22.16	gallons/connection/day
Real Losses per service connection per day*:	112.51	gallons/connection/day
Real Losses per length of main per day*:	N/A	
Real Losses per service connection per day per psi pressure:	2.05	gallons/connection/day/psi
Unavoidable Annual Real Losses (UARL):	2,001.95	million gallons/year
From Above, Real Losses = Current Annual Real Losses (CARL):	18,428.49	million gallons/year
Infrastructure Leakage Index (ILI) [CARL/UARL]:	9.21	



AWWA WLCC Free Water Audit Software: Water Balance

WAS v4.2

Water Audit Report For: Miami Dade WASD

Report Yr: 2013

Own Sources (Adjusted for known errors) 109,674.040	Water Exported 22,966.189			Billed Water Exported	
	Water Supplied 86,887.594	Authorized Consumption 64,829.601	Billed Authorized Consumption 63,722.316	Billed Metered Consumption (inc. water exported) 63,722.316	Revenue Water 63,722.316
				Billed Unmetered Consumption 0.000	
			Unbilled Authorized Consumption 1,107.285	Unbilled Metered Consumption 21.190	Non-Revenue Water (NRW) 23,165.278
				Unbilled Unmetered Consumption 1,086.095	
		Water Losses 22,057.993	Apparent Losses 3,629.503	Unauthorized Consumption 217.219	
				Customer Metering Inaccuracies 1,500.615	
				Systematic Data Handling Errors 1,911.669	
Water Imported 179.743			Real Losses 18,428.490	Leakage on Transmission and/or Distribution Mains Not broken down	
				Leakage and Overflows at Utility's Storage Tanks Not broken down	
				Leakage on Service Connections Not broken down	

Appendix C—Water Use Permit