WISCONSIN M36 WATER LOSS AUDITING

March 30, 2016

PILOT TRAINING PROGRAM

CAVANAUGH
Stewardship Through Innovation

Contents

Executive Summary

The State of Wisconsin is located in a water rich region, with surface water, groundwater, and ample rainfall. The proximity to water sources, however, does not exclude communities from water quality and supply issues. Water supply challenges and the need for robust conservation planning are driven by increasing customer demand, declining groundwater supplies, and aging utility infrastructure. Water Loss Control is an important part of water resource management for water utilities and state agencies. Wisconsin, through a collaborative effort from the Public Service Commission of Wisconsin (PSC), the Wisconsin Section of the American Water Works Association (WIAWWA), the Wisconsin Department of Natural Resources (DNR), and Cavanaugh & Associates, P.A. (herein referred to as the Cavanaugh Team), has taken the step to enhance the state's water loss programs by implementing a pilot program to train utilities in analysis and management of non-revenue water. A 2011 statewide study[1] identified water loss control as the most cost-effective means for water utilities to achieve water conservation – by a wide margin. This report helped focus the PSC's Water Conservation Initiative. The aim of this pilot training program was to guide and advance adoption of best-practices for water loss control in the State of Wisconsin. The pilot program demonstrated willingness and ability of the pilot utilities to learn the AWWA water loss auditing & validation practices, and using the AWWA methods provided superior insight into the utilities' system efficiency. Recommendations from the pilot program are to move to statewide training and technical assistance to the majority of water utilities regulated by the PSC.

Purpose

The M36 Water Loss Auditing Pilot Training Program's primary objectives were to introduce the American Water Works Association (AWWA) methodology and tools to reduce water loss, evaluate the PSC water loss data collection practices, evaluate the potential for driving utilities' water loss programs from audit to action, and inform policy makers of broad scale needs of statewide Training and Technical Assistance.

There are several key stakeholders and utility partners invested in the Pilot Training Program:

Table 1: Project Stakeholders

Organization	Organizational Role	Primary Contact
Fund for Lake Michigan	Project funding	Vickie Elkin
Wisconsin Department of Natural Resources (DNR)	Project funding	Kimberly Walz
Public Service Commission of Wisconsin (PSC)	Agency support	Denise Schmidt
Wisconsin Section of the American Water Works Association's (WIAWWA)	Association support	Frank Miller
Wisconsin Rural Water Association (WRWA)	Training Assistance provider	Dave Lawrence
Wisconsin Community Action Program Association (WISCAP)	Training Assistance provider	Wesley Hoem
Cavanaugh & Associates	Subject Matter Expert	Steve Cavanaugh, P.E. Will Jernigan, P.E. Tory Wagoner, P.E. Drew Blackwell

[1] http://psc.wi.gov/conservation/documents/waterEfficiencyDec2011.pdf

Program Overview

The concept of the Pilot Training Program was derived from current and potential water loss policies in the state, available water loss control resources to address utility needs, and the opportunity to demonstrate an effective use of funds to enhance the efficiency of public and private water systems in Wisconsin.

Program Development

As outlined in Wis. Stat. §196.07, every public utility is required to "file with the commission the balance sheet together with any other information the commission prescribes, verified by an officer of the public utility." Since 1972, PSC annual reporting requirements have included water audit data. In addition, Wisconsin Administrative Code NR 852.04 requires that public utilities, under certain circumstances related to increased or new water withdrawals, diversions or consumptive use, perform a water use audit according to PSC procedures and prepare written documentation of the audit results. As a result, use of the AWWA M36 methodology is not entirely new to Wisconsin utilities. However, PSC reports and procedures do not currently require use of AWWA's Free Water Audit Software, and statewide training and promotion of this tool is not currently available on a statewide basis. The Pilot Training Program was developed to provide participant utilities with a foundational understanding of the AWWA M36 methodology, how it is applied, and how water audit data may be used to assess and improve Water Loss performance at the utility level. Utilities were trained to use the AWWA free water audit software, water audit validation and water loss control program design. The training focused on the detailed data validation process and work with the utilities to roll out improved data management practices and water loss control activities based on their specific audit results.

Six utilities, referenced in Table 2, were selected to participate in the Pilot Training Program. In addition, several training assistance providers that had some knowledge of, and/or may benefit from, the water audit content participated in the program.

Table 2: Utility Partners

Water Utilities in Pilot Program	
Milwaukee Water Works	Port Washington
Kenosha Water Utility	Cudahy
Oak Creek	Mequon (City Water)

Key differences in method and metrics between the AWWA M36 and PSC reporting requirements were noted throughout the Pilot Training Program in order to evaluate approaches to identifying non-revenue water (NRW) and recommendations to address water losses.

Program Execution

The Pilot Training Program was designed to cover three learning modules and break-out sessions over the course of two days. The program was delivered at the Cudahy Family Library, 3500 Library Avenue, Cudahy, WI 53110, on February 10, 2016 and February 11, 2016. A detailed agenda of the material covered is provided below.

DAY 1

Presentation: M36 Water Auditing – Foundations: Concepts, Terms & Metrics, AWWA Free Water Audit Software
Presentation: Developing the Inputs
Common Exercise: Populating the top-down audit inputs with the AWWA Free Water Audit Software (example data)
Breakout Exercise: Populating the top-down audit inputs with the AWWA Free Water Audit Software (Utility data)
Presentation: Validity Scoring & the Data Grading Matrix
Common Exercise: Developing the Grades (example data)
Breakout Exercise: Developing the Grades (Utility data)

DAY 2

Presentation: Review of Day 1 content
Breakout Exercise: Carryover of Day 1 exercises as needed
Presentation: Advanced levels of validation – Level 2, Level 3
Common Exercise: Assessing next steps for Data Validity (example data)
Breakout Exercise: Assessing next steps for Data Validity (Utility data)
Presentation: Introduction to Component Analysis
Common Exercise: Component Analysis exercise (example/Utility data)
Presentation: Audit to action – identifying next steps for Water Loss Control

Analysis – AWWA vs. PSC results

An important analysis of the Pilot Training Program is the comparison between utility audit results under current PSC reporting requirements and those under the AWWA Water Audit Software (WAS) and M36 methodology. The PSC report used in this comparison was the *PSC Annual Report for Municipal Water Utilities* (Year ended December 31, 2014), Pages WI-14 and WI-15. This analysis is conducted by 1) identifying the different data that is collected using both PSC and AWWA WAS methodologies (or in some cases, the same data, under different nomenclature), and then 2) comparing the results of the same data recorded; specifically in non-revenue water. Table 3, Differences in PSC and AWWA WAS metrics provides a summary of the same metrics from the two sources and where those values are observed, as well as metrics that are recorded in the AWWA WAS, but not in the PSC report.

PSC, Page W-15	Data Field Reference	AWWA Water Audit Software (WAS)	Data Field Reference
Line 6	Non-Revenue Water	Reporting Worksheet, Row 58	Non-Revenue Water
Line 12	Authorized System Uses	Reporting Worksheet, Sum of Rows 25 and 26	Unbilled Authorized Consumption
Line 19	Water Losses	Reporting Worksheet, Row 54	Water Losses
Line 21	Percentage of Real and Apparent Losses	Reporting Worksheet, Row 54 Divided by Row 19	Water Loss % of Supply
			Apparent Losses (MG)
			Real Losses (MG)
			Apparent Losses per service connection per day
			Real Losses per service connection per day
			Real Losses per length of main per day
			Infrastructure Leakage Index (ILI)

Same metric, but different nomenclature
Metrics tracked by AWWA WAS, but not by PSC

Table 3: Differences in PSC and AWWA Metrics

Observed in Figure 1 below, the volumes resulting from use of the shared metrics for the two different methodologies are not significantly different. Discrepancies in the results may be attributed to better data available at the time of the Pilot Training Program than the time the data was submitted for PSC reporting. However, observations from the data in Table 4 below begin to illustrate the different NRW components in the water audit that PSC reporting does not take into consideration. These NRW components are crucial to understanding the real and apparent water losses in a system; both in volume and in cost. The Wisconsin pilot utilities show an average apparent loss as 5 to 10% of total water losses. This is below the average of the same metric (approximately 14%) from the AWWA Water Audit Data Initiative dataset which represents a small sampling of early adopters for water auditing across North America. This may be correlated with the fact that Wisconsin utilities (public and private) have meter testing and replacement programs by mandate, which is not common in other jurisdictions.

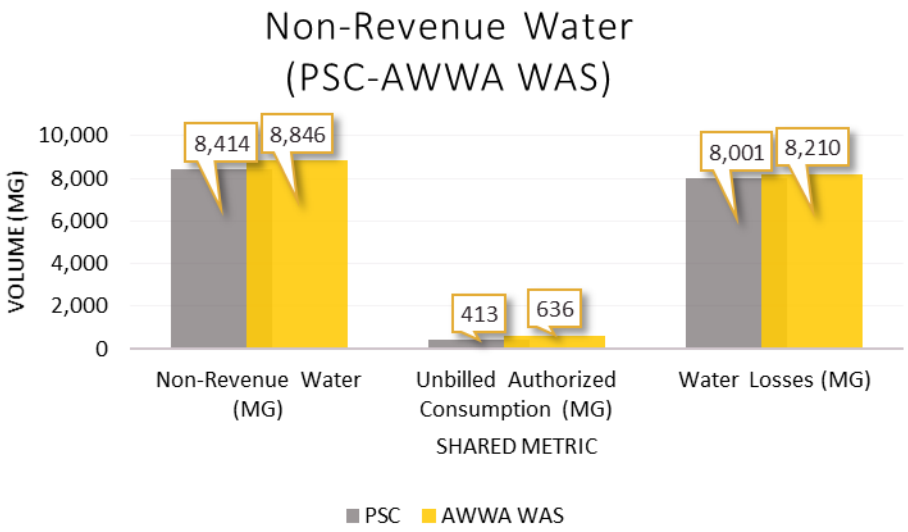


Figure 1 (left): Shared Non-Revenue Metrics (PSC-AWWA).

There are four specific metrics that are shared between both the PSC reporting and the AWWA Water Audit Software: Non-Revenue Water, Unbilled Authorized Consumption, Water Losses, Water loss % of Supply. Figure 1 (below), shows the combined volume of the six participant utilities among these shared metrics

Table 3 (below): Utility Data -- NRW PSC-AWWA Metrics.

There are six specific metrics not accounted for in the PSC reporting: Apparent Losses, Real Losses, Apparent Losses per serv conn/day, Real Losses per serv conn/day, Real Losses per length of main, and Infrastructure Leakage Index (ILI). In addition to showing volumes and values with these key performance indicators, the AWWA Water Audit Software can begin to assign the total cost of non-revenue water. These costs and recommendations for each utility based on the data provided can be found in the individual *Utility Profiles*.

Utility	Source	Water Produced + Purchased (MG)	Non-Revenue Water (MG)	Unbilled Authorized Consumption (MG)	Water Losses (MG)	Water loss % of Supply	Apparent Losses (MG)	Real Losses (MG)	Apparent Losses per serv conn/day (gal)	Real Losses per serv conn/day (gal)	Real Losses per length of main/day (gal)	Infrastructure Leakage Index (ILI)
Milwaukee	PSC	37,235	7,341	223	7,118	19%						
Milwaukee	AWWA	37,771	7,651	448	7,203	19%	189	7,014	3	101		5.9
Kenosha	PSC	4,532	675	147	528	12%						
Kenosha	AWWA	4,532	676	148	528	12%	110	418	10	39		2.4
Oak Creek	PSC	2,679	218	20	197	7%						
Oak Creek	AWWA	2,679	222	19	203	8%	25	178	7	53		3.0
Port Washington	PSC	432	63	2	61	14%						
Port Washington	AWWA	432	65	2	63	15%	4	59	3	41		2.3
Cudahy	PSC	943	104	11	93	10%						
Cudahy	AWWA	831	210	10	200	24%	20	180	10	90		6.8
City Water (Mequon)	PSC	384	13	9	5	1%						
City Water (Mequon)	AWWA	392	21	9	12	3%	5	8	6		238	

CUDAHY WATER UTILITY
(WI2410169)

Frank Miller, Superintendent

DEMOGRAPHICS
2014

POPULATION SERVED:
18,700
SYSTEM SOURCE:
Production (Lake Michigan)
CONNECTIONS:
5,489
MILES OF MAIN:
63
SERVICE CONNECTION DENSITY:
87 conn/mile main
AVERAGE OPERATING PRESSURE:
55.0 psi

WATER AUDIT RESULTS
2014

Data Validity Score:
54/100
Apparent Losses:
9.75 gal/serv conn/day
Real Losses:
90.05 gal/serv conn/day
Infrastructure Leakage Index (ILI):
6.80

Recommendations for Cudahy Water Utility

Flow Meter Testing

Develop and implement a volumetric (reservoir drop) test protocol for finished water meter flow verification.

Billed Metered

Resolve differences in totals from multiple reports (annual vs. summed monthly); confirm units.

Customer Metering

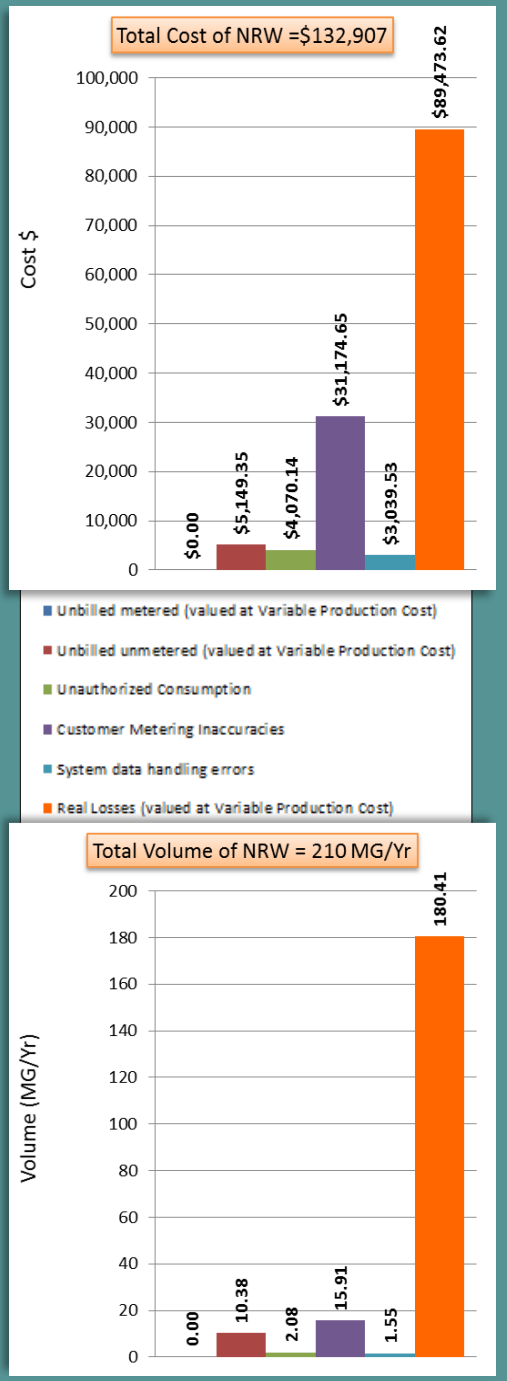
Improve customer meter testing practices beyond large meters. Evaluate random statistical sampling of small meters at varying throughput by demographic subgroups.

Explore secondary costs for updated variable production costs

Evaluate applicability and derivation of residuals management, dynamic asset depreciation, leakage-based liability and impending expansion of supply for inclusion in annual Variable Production Cost calculation.

Compare existing tracking of unbilled uses to default

Evaluate volumes as currently tracked, including gross estimation of applicable volumes not tracked against standard default of 1.25% of water supplied. Utilize the lesser of the 2 values.



KENOSHA WATER UTILITY
(WI2300046)

Dave Lewis, Assistant General Manager
Cathy Brnak, Director of Business Services

DEMOGRAPHICS
2014

POPULATION SERVED:
100,000
SYSTEM SOURCE:
Production (Lake Michigan)
CONNECTIONS:
36,747
MILES OF MAIN:
367
SERVICE CONNECTION DENSITY:
81 conn/mile main
AVERAGE OPERATING PRESSURE:
61.5 psi

WATER AUDIT RESULTS
2014

Data Validity Score:
58/100
Apparent Losses:
10.16 gal/serv conn/day
Real Losses:
38.67 gal/serv conn/day
Infrastructure Leakage Index (ILI):
2.42

Recommendations for Kenosha Water Utility

Volume from Own Sources
Conduct hydraulic flow verification testing on finished water meter (a single magmeter – 48" line).

Volume from Own Sources: Master Meter & Supply Error Adjustments
Utilize above noted test results for derivation of this input.

Water Exported
Analyze specific test results from 3 export meters for derivation of error adjustment. Verify anomaly in Pleasant Prairie August consumption.

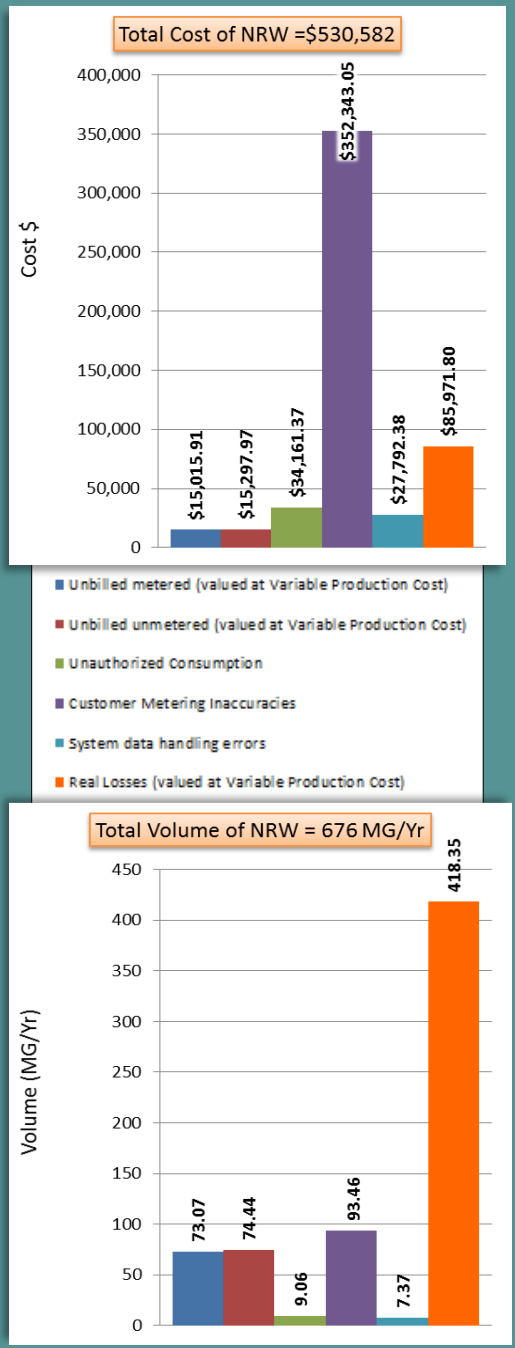
Unbilled Metered
Conduct review of accounts to verify WWTP is only account designated unbilled status.

Unbilled Unmetered
Need to clarify 'other system uses' in PSC report.

Customer Metering Inaccuracies
Develop input from meter testing results database.

Active + Inactive Connections
Confirm inclusion of inactive connections in the total.

Average Length of Customer Service Line
Conduct study on available asset database for investigation of this estimate.



MEQUON WATER UTILITY
(WI2460112)

Jim Voigt, City Water
Tom Nenning, City Water

City Water, LLC

DEMOGRAPHICS
2014

POPULATION SERVED:
7,640
SYSTEM SOURCE:
Imported
CONNECTIONS:
2,219
MILES OF MAIN:
87
SERVICE CONNECTION DENSITY:
26 conn/mile main
AVERAGE OPERATING PRESSURE:
65.0 psi

WATER AUDIT RESULTS
2014

Data Validity Score:
57/100
Apparent Losses:
5.98 gal/serv conn/day
Real Losses:
237.85 gal/mile/day
Infrastructure Leakage Index (ILI):
0.30

Recommendations for Mequon Water Utility

Flow Meter Testing

Results were provided for the meters while at the workshop. Follow-up weighted flow balance (weighted calculation) was planned for future application of these test results.

Export adjustment

Establish a written agreement with exporters as a delineation of responsibilities for meter testing and repair protocol. Perform weighted calculation to generate composite accuracy which represents all source meters.

Billed Metered

Discovery was made during the workshop of additional metered volumes which were not part of the system network. Implement annual auditing of detailed billing records by utility personnel and work to establish a custom query in billing system to account for system meters only.

Systematic Data Handling Errors

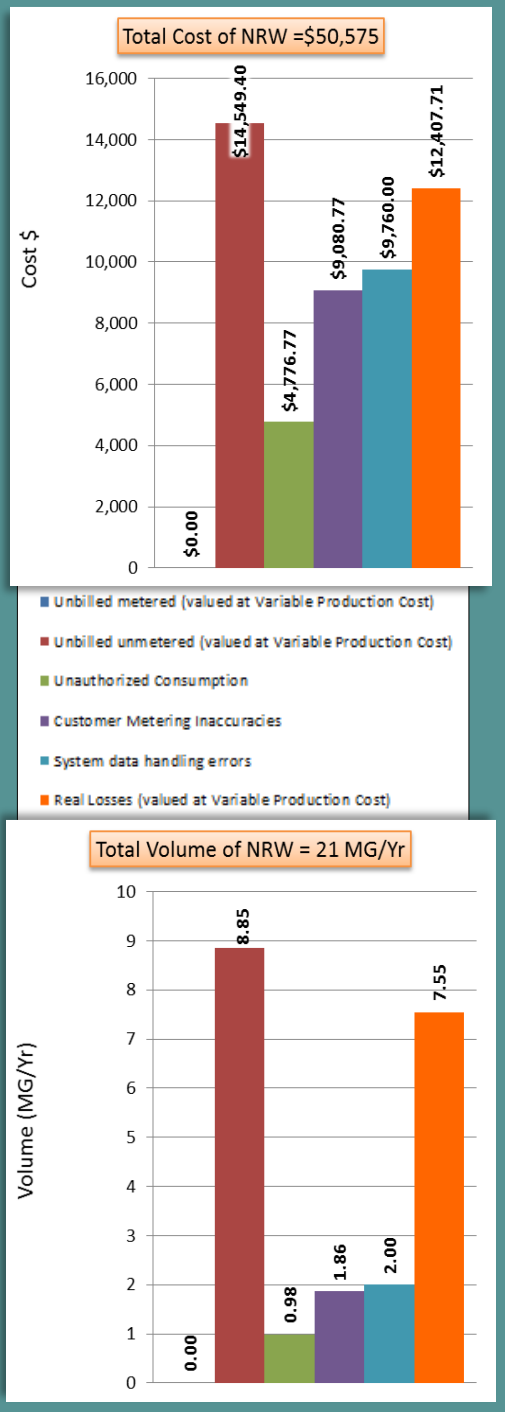
Modify customer billing system for needed functionality, also ensure that billing volume adjustments don't corrupt the value of consumption volumes. Establish procedures to acquire custom reports from the billing software which can be provided on a routine basis. Establish internal annual audit process.

Active and Inactive service connections

Initial balance comparing number of service connections to the numbers of meters was significant. Check discrepancies such as: multi-family connections (1 connection with multiple meters) and associated documentation

Variable Production Cost

Implement internal auditing on a periodic basis



Milwaukee Water Works

Safe, Abundant Drinking Water.

MILWAUKEE WATER UTILITY (WI2410100)

Carrie Lewis, MWW Superintendent
Tim Ignatowski, Accountant III, Public Works—Water
Jeff Novak, Water Business Operations Manager, Public Works—Water
Joe Leszczynski, Office Assistant III, Neighborhood Services
Ross Brzycki, Water Distribution Business System Supervisor

DEMOGRAPHICS
2014

POPULATION SERVED:
865,000
SYSTEM SOURCE:
Production (Lake Michigan)
CONNECTIONS:
191,046
MILES OF MAIN:
2,038
SERVICE CONNECTION DENSITY:
94 conn/mile main
AVERAGE OPERATING PRESSURE:
68.4 psi

WATER AUDIT RESULTS
2014

Data Validity Score:
66/100
Apparent Losses:
2.71 gal/serv conn/day
Real Losses:
100.59 gal/serv conn/day
Infrastructure Leakage Index (ILI):
5.87

Recommendations for Milwaukee Water Works

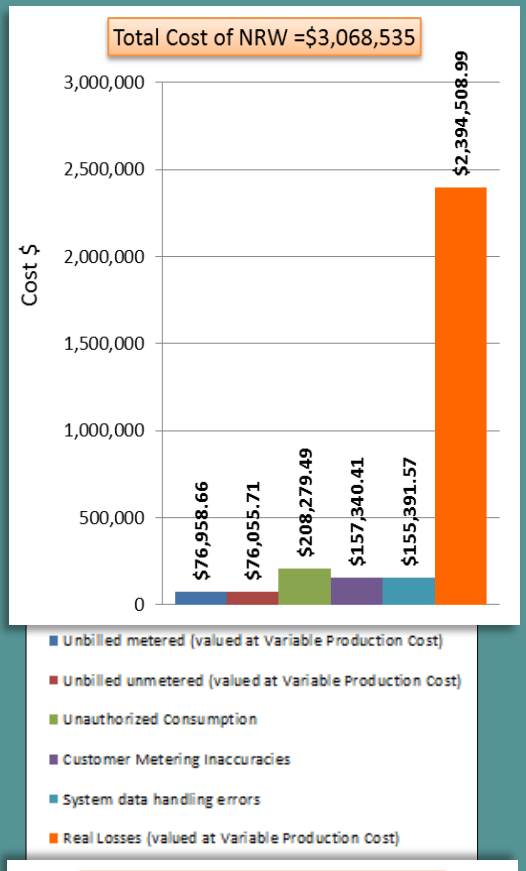
Volume from Own Sources
Conduct hydraulic flow verification testing on finished water meters. As there are a large number of these meters, the volume measured by each meter in conjunction with the adequacy of upstream/downstream clearances at the meter location could be considered as a ranking criteria. Verify and document legitimacy of negative supply volumes on Low Service District – Howard.

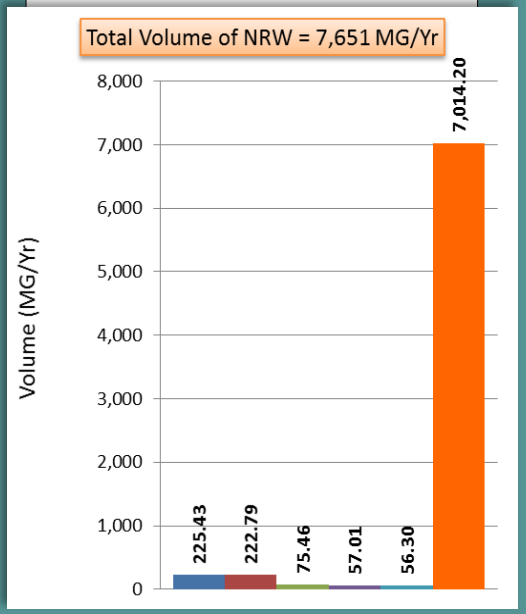
Volume from Own Sources: Master Meter & Supply Error Adjustments
Utilize above noted test results for derivation of this input.

Water Exported
Analyze specific test results from 10 export meters for derivation of error adjustment.

Average Length of Customer Service Line
Conduct study on available asset database for investigation of this estimate.

Average Operating Pressure
Investigate true average pressure by pressure district, then conduct weighted average among all pressure districts using number of connections as basis for weighting.





OAK CREEK WATER UTILITY (WI2410172)

Doug Schwartz, Distribution Manager

DEMOGRAPHICS
2014

POPULATION SERVED:
32,100
SYSTEM SOURCE:
Production (Lake Michigan)
CONNECTIONS:
9,148
MILES OF MAIN:
194
SERVICE CONNECTION DENSITY:
47 conn/mile main
AVERAGE OPERATING PRESSURE:
56.1 psi

WATER AUDIT RESULTS
2014

Data Validity Score:
64/100
Apparent Losses:
7.48 gal/serv conn/day
Real Losses:
53.42 gal/serv conn/day
Infrastructure Leakage Index (ILI):
2.96

Recommendations for Oak Creek Water Utility

Flow Meter Testing

It does not appear this has been done. Flow meter testing can explore volumetric testing as a first option. Develop and implement a volumetric (reservoir drop) test protocol for finished water meter flow verification. If volumetric testing not viable, evaluate insertion-type testing.

Export Adjustment

Export meters are present in the meter testing data, but there is not enough information to determine which meter it was. Evaluate performing a weighted average.

Explore secondary costs for updated variable production costs

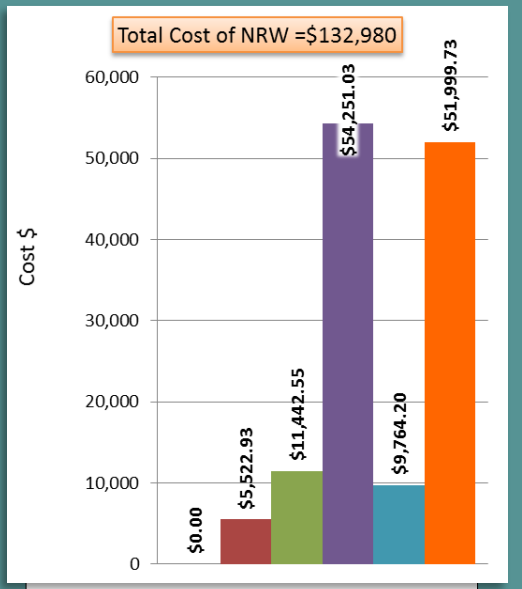
Evaluate applicability and derivation of residuals management, dynamic asset depreciation, leakage-based liability and impending expansion of supply for inclusion in annual Variable Production Cost calculation.

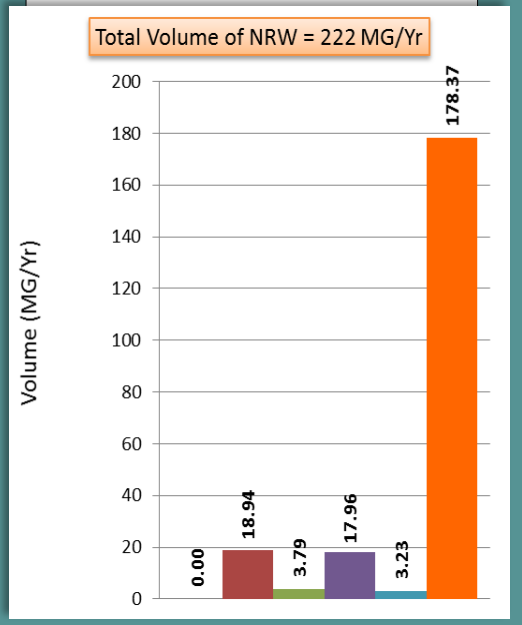
Update mains length using GIS information rather than estimate on hydrant legs

Confirm hydrant count in mapping database. Confirm approximation of average hydrant length as practical to finalize calculation.

Comparing existing tracking of unbilled uses to default

Evaluate volumes as currently tracked, including gross estimation of applicable volumes not tracked against standard default of 1.25% of water supplied. Utilize the lesser of the 2 values.





PORT WASHINGTON WATER UTILITY (WI2460054)

Dave Kleckner, Port Washington

DEMOGRAPHICS
2014

POPULATION SERVED:
11,300
SYSTEM SOURCE:
Production
CONNECTIONS:
3,970
MILES OF MAIN:
60
SERVICE CONNECTION DENSITY:
66 conn/mile main
AVERAGE OPERATING PRESSURE:
65.0 psi

WATER AUDIT RESULTS
2014

Data Validity Score:
68/100
Apparent Losses:
2.65 gal/serv conn/day
Real Losses:
40.72 gal/serv conn/day
Infrastructure Leakage Index (ILI):
2.34

Recommendations for Port Washington Water Utility

Volume from own Sources
It was noted that treatment plant process water is withdrawn from the distribution supply line (as a negative mag meter flow) which is potentially corruptive to the actual supply amount. Further investigation is recommended to better understand with the aim to separate the process water from the metered supply.

Flow Meter testing
Validity to meter testing method and results remain a priority. Once the above correction is resolved, follow-up meter tests should be considered. Explore a volumetric test method as an option. Explore utilizing a weighted flow calculation to develop a master error adjustment from the test results.

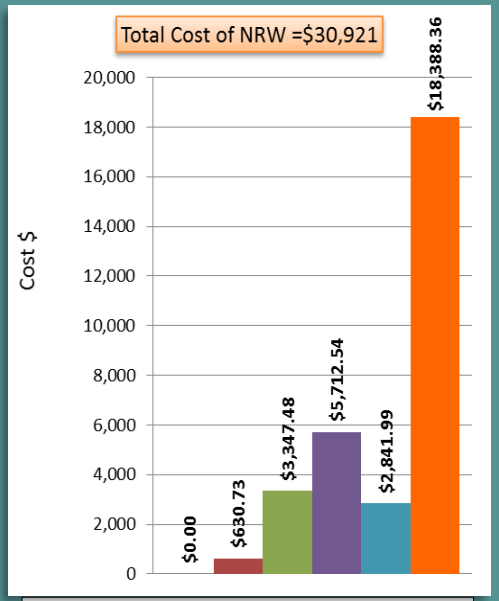
Unbilled Unmetered

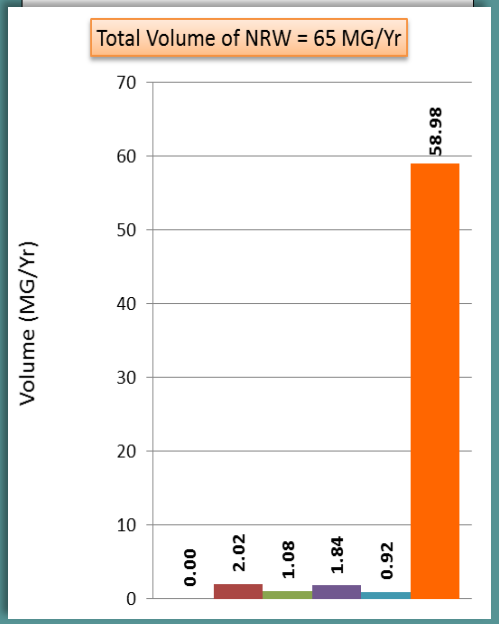
Input volume is approximately 50% of the default. Verify that procedures to quantify (estimate) these volumes is correct. Explore “other sources” of possible volumes in this category such as fire department uses. Removed main breaks volume from the authorized consumption.

Active and Inactive service connections
Verify that input number contains both active and inactive service connections.

Average Operating Pressure
Consider using a weighted calculation with field verification at various high and low sites for each pressure zone.

Total Operating Cost
Verify and resolve any potential discrepancies between internal and reported values





Program Feedback

Survey Responses

Survey responses of attendees were solicited by the Cavanaugh Team. Of those that responded, 100% rated the overall quality of the training as 'Very Good,' and the pace of the class as 'About Right.' Additional responses to gauge the effectiveness of the program and the ease of use of the AWWA WAS are indicated below.

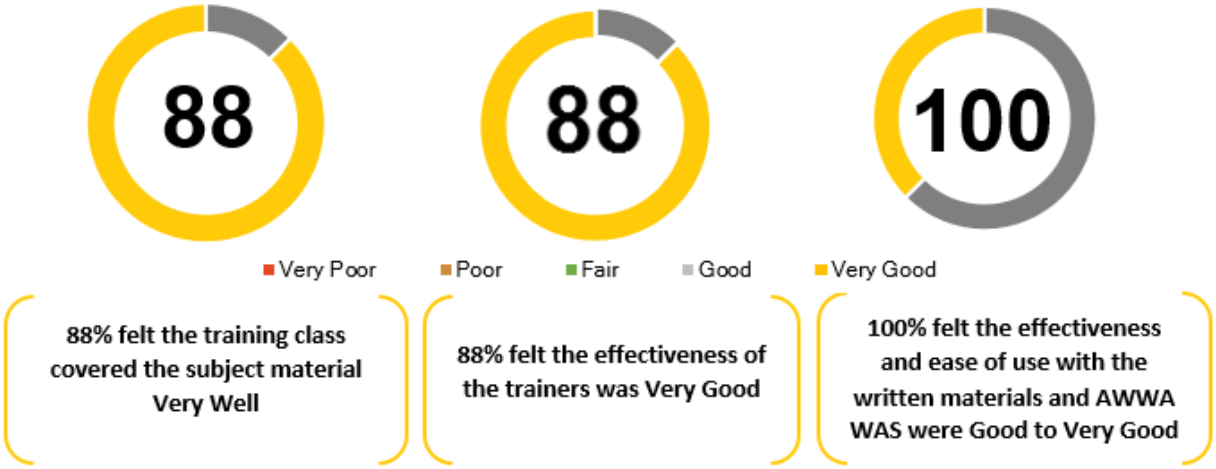


Figure 2: M36 Water Loss Auditing Pilot Training Program - Survey Responses

> THE CAVANAUGH TEAM WAS VERY KNOWLEDGEABLE ABOUT USING THE AWWA WATER LOSS SOFTWARE. WHEN I CAME TO THE SESSION, I HAD DOUBTS ABOUT IF I WOULD AGREE WITH THE CHANGE IN REPORTING THAT THE PSC IS NOW PLANNING ON IMPLEMENTING. HOWEVER, AFTER THE SESSION, I BELIEVE THAT IT IS PROBABLY A POSITIVE CHANGE. THERE WILL BE SOME GROWING PAINS IN ORDER TO IMPLEMENT THE SOFTWARE, BUT IN TIME UTILITIES WILL BENEFIT FROM A METHOD THAT SCORES HOW THEY ARE DOING. IT WAS A LOT TO PACK INTO 2 DAYS BUT IF WE DO OUR HOMEWORK AND WORK TO IMPROVE GOING FORWARD THE CHANGE WILL PROBABLY BE FOR THE BEST.
>
> Kenosha Water Utility

Recommendations for Improvement

In additions to the positive aspects of the pilot program, the Cavanaugh Team captured some key feedback from the participants on how to improve the class.

What would you like to see done differently?

- Additional time to cover the overall material would be beneficial
- Additional time dedicated to Component Analysis
- More diverse scenarios (e.g. examples of smaller groundwater systems)

What additional training and/or technical assistance would you be interested in after completing the initial Pilot training workshop?

- A refresher course if PSC 185 is revised to require use of AWWA WAS
- A refresher on overall concepts, weighted averaging, and follow up with the validation progress

What training and/or technical assistance do you think would be beneficial to other utilities in Wisconsin that were not included in the Pilot training workshop?

- This training is definitely needed for smaller systems throughout the state
- Assistance in completing the audit
- Several workshops for small utilities spread throughout the state would be very beneficial; needs to be, at a minimum, a one day class. Strongly encourage the clerk or treasurer to attend these classes, since they work in unison with operational staff to complete the PSCW annual report
- A more comprehensive training class tailored towards the size of the utilities

Summary of Recommendations

The Pilot Training Program introduced the participating utilities to the key concepts of water auditing and water loss control: the water balance and awareness to separate components of non-revenue water, data validity, analyses of non-revenue water components, and prioritization of those components in planning solutions. These key concepts were examined against current PSC reporting metrics and will become crucial for water systems to understand as state regulations trend toward a more focused approach using the AWWA Free Water Audit Software in the next update of Chapter PSC 185, Standards for Water Public Utility Service. For example, some utilities observed high volumes of losses using the traditional reporting format. This result may lead utilities to default to the traditional approach of heavier investment in leak detection. However, the AWWA Water Audit Software identified other components of loss - metering inaccuracies, for example – that can support more strategic, data-driven investment decisions that are specific to their systems.

The approach for the next phase of a full-scale program implementation is a recommendation to focus on conducting the top-down M36 water audit (using AWWA Free Water Audit Software), and taking the audit through a Level 1 Validation review. It is critical that the training include a heavy focus on validation. Recent research into the growing number of water audits collected in jurisdictions around the United

States has identified a widespread challenge in water audit data validity[2,3]. The underlying causes in data inaccuracies, as identified by the research, are not lack of competencies by the utility staff, but rather inherent characteristics of the systems that generate the data needed for the water audit – including supply metering, SCADA systems, customer metering systems, customer billing systems, and work order systems. Each of these systems in a water utility was designed for its specific purpose and is fully functional in its own right. However, these systems were not designed specifically for the purpose of extracting data to develop a precise, spatially and temporally bound water balance for conducting detailed water loss analysis. When they are called upon to provide such precise information, there are many challenges that can arise with regard to data accuracy. Some data systems are more accommodating than others, but none of them was designed specifically for this purpose. Training on how to populate the AWWA Free Water Audit Software is an important first step, but it is essential that the training also include a detailed understanding of validation of that data, if one wants to obtain meaningful and reliable water audit results. Having meaningful and reliable audit results every year is essential for the regulatory agencies and the water utilities alike.

The full group of regulated utilities under PSC's jurisdiction is 582. The count of utilities above a service population of 3,300 is approximately 183, which constitutes approximately 87% of the service population in Wisconsin. To maximize the impact on aggregate water withdrawals in the state as well as the number of ratepayers benefiting from adoption of best practices, it is recommended that the next phase of training and technical assistance target utilities that serve 3,300 population and above. The specific scope and scale of the next phase will be dependent upon the source and level of funding available. Several states in the U.S. are leveraging the State Revolving Fund set-asides to fund training and technical assistance programs for water auditing & loss control, as these activities advance building technical, financial and managerial capacity in the water utilities.

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[2] WRF 7372 A & B: Water Audits and Real Loss Component Analysis. 2014-15. Water Research Foundation, Denver, CO. http://www.waterrf.org/Pages/Projects.aspx?PID=4372

[3]WRF 4639: Establishing Water Utility Guidance and Methodology for Water Audit Validation. 2016. Water Research Foundation, Denver, CO. http://www.waterrf.org/Pages/Projects.aspx?PID=4639