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Department of Natural Resources

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TO: Colorado Water Conservation Board Members

FROM: Kevin Reidy, Water Supply Planning Section

DATE: January 25, 2016

AGENDA ITEM: Agenda Item #14, AWWA M36 Water Loss Audit Pilot Training Program Workshops

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Background:

In September 2015, the CWCB funded a set of pilot workshops centered on the AWWA M36 Water Audit and Loss Control methodology through the Water Efficiency Grant fund. Colorado WaterWise was the fiscal agent and hired Cavanaugh and Associates to design the curriculum and carry out the workshops. The workshops took place in Grand Junction, Frisco, Pueblo, Greeley and Denver.

The M36 Water Audit and Loss Contol Methodology is the accepted international standard for assessing non revenue water sources and validating the data generated from the process. According to data collected through the HB10-1051 process, only 30% of the submitters stated that they were using some form of the M36 methodology.

The goals of the workshops were to introduce utility personnel to the basic water audit process and all the related components, assess the level of awareness of the M36 methodology, and to assess interest in deeper and broader training on a statewide level.

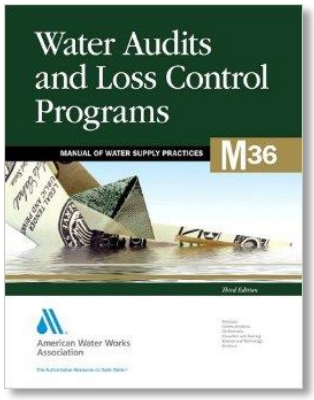
The workshops were very successful with almost 100 attendees. Feedback from attendees was positive and there is an interest for a greater statewide training effort in order for water providers to implement water loss best practices that stem from the M36 methodology.

Staff Recommendation: This is an informational item only. No Board action is required.

Attachment: Program Report- Colorado AWWA M36 Water Loss Audit Pilot Training Program

Colorado AWWA M36 Water Loss Audit Pilot Training Program

Program Report



Prepared for: Colorado Water Wise

Prepared by: Cavanaugh

September 2015

Project Partners:

COLORADO
Colorado Water Conservation Board
Department of Natural Resources

colorado waterwise

CAVANAUGH
Stewardship Through Innovation

Water Research Foundation℠

American Water Works Association
Rocky Mountain Section

Introduction & Background

The Colorado General Assembly adopted House Bill (HB) 10-1051 in 2010. This bill requires covered entities to report water use and conservation data to be used for statewide water supply planning, on an annual basis. The Colorado Water Conservation Board (CWCB) is responsible for administering the annual reporting requirement. CWCB conferred with Colorado Water Wise (CWW), a non-profit water conservation organization, to develop a pilot training program. The concepts of non-revenue water (NRW) and water loss control are at the core of the training program. The program's mission was to support the annual reporting requirement, teaching covered entities how to conduct an M36 water audit and interpret results. CWW worked with Cavanaugh as the subject matter expert and training agent to execute the pilot training program.

Training Content Overview

Training content for the program focused on foundational training on the AWWA M36 Water Auditing & Loss Control Methodology. This methodology emphasizes the top-down IWA/AWWA Water Audit (water audit) and bottom-up validation practices.

Water Audit Methodology

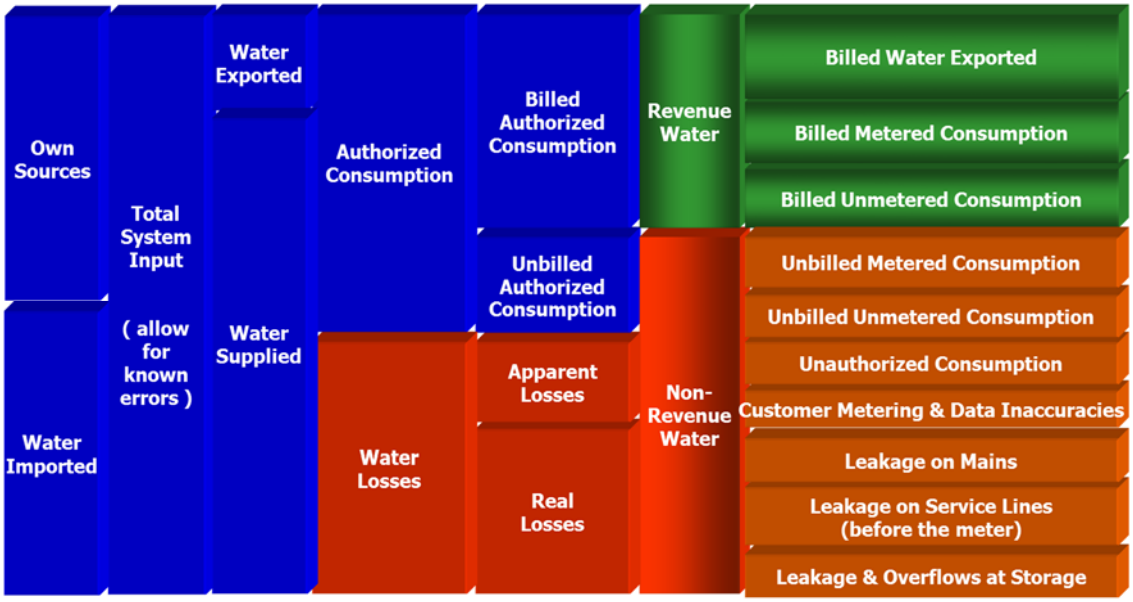


Figure 1. AWWA M36 Water Balance.

The water audit methodology accounts for all finished water in a system, by employing the water balance. The water balance allows water to be traced from its point of production, quantifying its use by customers and the utility for consumption, operation and as water loss. The water balance method quantifies total water loss, separating it into its components, real and apparent loss. It also separates these components into subcomponents. The subcomponents of real loss are background leakage, unreported leakage and reported leakage. The subcomponents of apparent loss are customer metering inaccuracies, data handling errors and theft.

The top-down approach functions as the primary desktop exercise of gathering information from existing system records, procedures and data, and is the recommended starting point for any system. The bottom-up validation practices focus on validating the data gathered during the top-down exercise, including field measurements.

Data Validation

The following figure represents the water loss control planning matrix from the M36 water audit software, with functional guidance for varying levels of water audit data validity scoring.

	Water Audit Data Validity Level / Score				
Functional Focus Area	**Level I** (0-25)	**Level II** (26-50)	**Level III** (51-70)	**Level IV** (71-90)	**Level V** (91-100)
Audit Data Collection	Launch auditing and loss control team; address production metering deficiencies	Analyze business process for customer metering and billing functions and water supply operations. Identify data gaps.	Establish/revise policies and procedures for data collection	Refine data collection practices and establish as routine business process	Annual water audit is a reliable gauge of year-to-year water efficiency standing
Short-term loss control	Research information on leak detection programs. Begin flowcharting analysis of customer billing system	Conduct loss assessment investigations on a sample portion of the system: customer meter testing, leak survey, unauthorized consumption, etc.	Establish ongoing mechanisms for customer meter accuracy testing, active leakage control and infrastructure monitoring	Refine, enhance or expand ongoing programs based upon economic justification	Stay abreast of improvements in metering, meter reading, billing, leakage management and infrastructure rehabilitation
Long-term loss control		Begin to assess long-term needs requiring large expenditure: customer meter replacement, water main replacement program, new customer billing system or Automatic Meter Reading (AMR) system.	Begin to assemble economic business case for long-term needs based upon improved data becoming available through the water audit process.	Conduct detailed planning, budgeting and launch of comprehensive improvements for metering, billing or infrastructure management	Continue incremental improvements in short-term and long-term loss control interventions
Target-setting			Establish long-term apparent and real loss reduction goals (+10 year horizon)	Establish mid-range (5 year horizon) apparent and real loss reduction goals	Evaluate and refine loss control goals on a yearly basis
Benchmarking			Preliminary Comparisons - can begin to rely upon the Infrastructure Leakage Index (ILI) for performance comparisons for real losses (see below table)	Performance Benchmarking - ILI is meaningful in comparing real loss standing	Identify Best Practices/ Best in class - the ILI is very reliable as a real loss performance indicator for best in class service

Figure 2. AWWA Water Loss Control Planning Guide.

Briefly mentioned in the section above, data validation of the water audit begins to occur during the bottom-up validation practices. Validation of the data is an important step as it is an indicator on what logical steps should be taken when implementing water loss controls. Data validity also provides a quantitative measure of the reliability of the data. The data validity score, composed of weighted grading from audit inputs, is the key indicator that communicates next steps that should be taken in water loss control planning. Data grading is assessed on a level of 1 – 10 for each input, with 1 being a guesstimate and 10 being an exacted, measured and supported piece of data. Data validity score is assessed on a level of 0 -100.

Component Analysis

Component analysis is a method that models leakage volumes (real loss) based on the nature of leakage occurrence and duration.

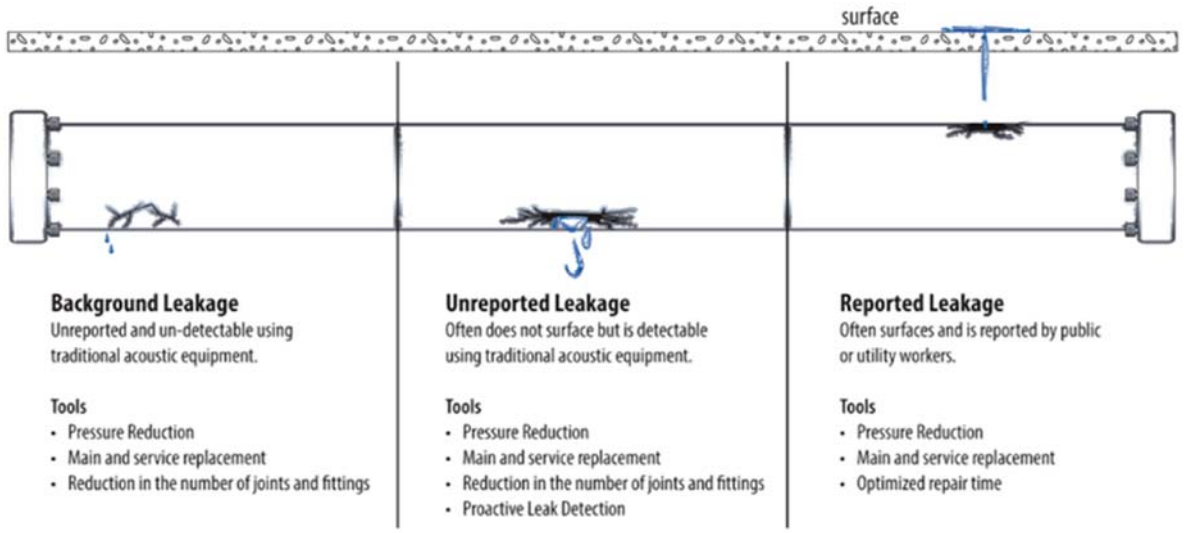


Figure 3. Real loss components – 3 kinds of leakage.

As demonstrated in Figure 3 above, component analysis helps to quantify the components of real loss – background leakage, unreported leakage and reported leakage. Component analysis can also be used to model apparent loss, examining the nature and duration of these events. Separating loss into its respective components allows the appropriate tools to be selected and applied for each component, increasing the effectiveness of a water loss control program. As described to participants in the workshops, the intention of component analysis from a utility management position, is to break water loss into small enough parts so that an applicable solution for control, can be applied.

Marketing Efforts and Utility Engagement

Statewide Utility Profile

Below are statistics on the distribution of water systems by size (number of connections), for all water systems serving greater than 3,300 in population (n=159). This delineation is estimated to represent approximately 95% of the service population in the State of Colorado. Statewide statistics on water loss and NRW water are unavailable, but benchmarks from validated national water audit data indicate an average of approximately 30,000 gallons of NRW per service connection each year. This translates to an estimated 41 Billion Gallons of NRW every year in the State of Colorado. The goal of the pilot training was to reach as many of these 159 utilities as possible, with the majority of the effort targeted at covered entities, via regional workshop circuit approach.

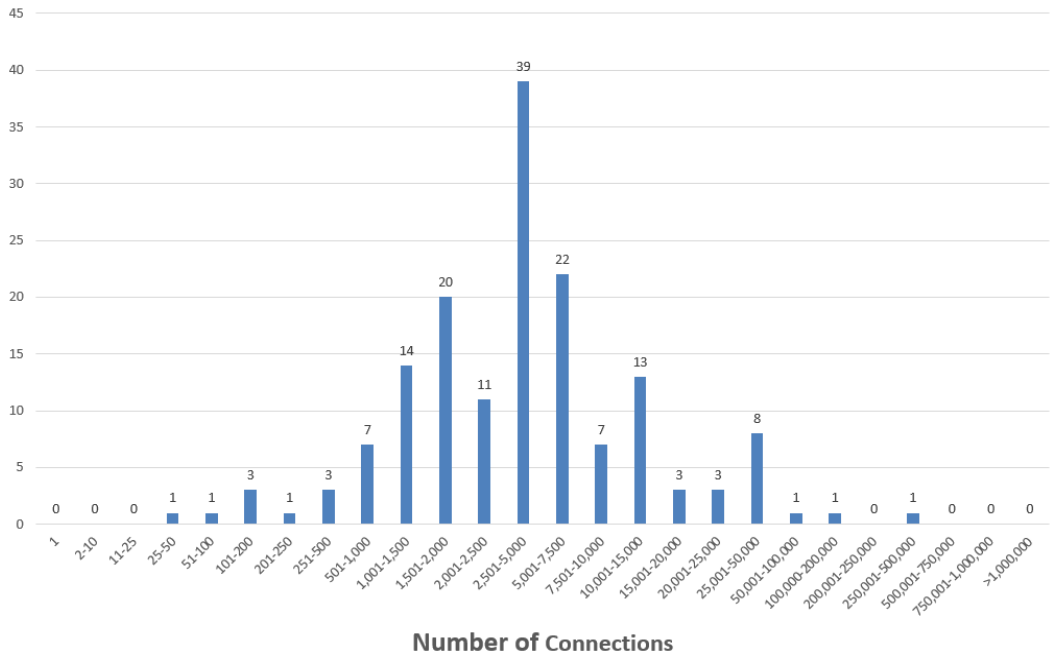


Figure 4. Statewide utility statistics – utilities serving >3,300 population.

Target Participants – 81 covered entities

Out of the 159 Colorado utilities serving greater than 3,300 in population, 81 were covered entities. According to Colorado Revised Statute 37-60-126, a covered entity is any entity with a legal obligation to supply, distribute, or provide water at retail to customers. A covered entity also has a total customer demand of 2,000 acre-feet or more.

A promotions plan was created to engage covered entities participation in the training program. As a part of the plan, email content announcing the training program and encouraging registration, was distributed to members and affiliates on a targeted timeline. A registration website was launched for participants to sign-up for the program. Cavanaugh led outreach efforts by contacting each covered entity on an individual basis, placing phone calls and follow-up encouragement emails. Cavanaugh also generated web copy to be placed on stakeholder websites informing of and encouraging program participation.

Overall Strategy for Learning Model

Webcast

On August 19th, a webcast was conducted and served as an introduction to the training program. With roughly half of the covered entities participating, participants were introduced to the workshop training team and the AWWA M36 methodology. Participants also learned what to expect during the training workshops and gained a fundamental knowledge on water auditing basic concepts to include NRW and Data Validity. The webcast well prepared the participants for the workshops, helping them to formulate questions and begin the thought process of how concepts introduced would have an impact on their utility.

Workshops

As the core of the training program, in person workshops were conducted regionally across the State of Colorado, in the following locations and timeframe: Grand Junction (9/21/15), Frisco (9/22/15), Pueblo (9/23/15), Greeley (9/24/15) and Denver (9/25/15). Workshops provided the framework for participants to learn about the AWWA M36 Water Audit Methodology in greater depth. Participants learned more about concepts introduced during the webcast, with the flow of the day covering content and working through hands-on exercises as follows:

- Top Down M36 Water Audit Foundations and Exercise
- Data Validation Foundations and Exercise
- Component Analysis Foundations and Exercise

The goal of the workshops was to have participants learn and apply the following core concepts:

1. Utilize the Water Balance,
2. Separate Total Water Loss into Real and Apparent Loss,
3. Separate Real and Apparent Loss into their subcomponents, and
4. Use metrics in units of Volume, Value & Validity.

Program Outcomes

Attendance Statistics

The following section outlines attendance and participant feedback details from the training workshops. The following table illustrates attendance statistics for each workshop.

Workshop Location	Total Individuals Registered	Total Individuals Attended
Grand Junction	9	7
Frisco	19	17
Pueblo	19	16
Greeley	25	25
Denver	36	29
Total:	108	94

Table 1. Workshop attendance statistics.

The following figure illustrates total systems attending the training workshops, by type.

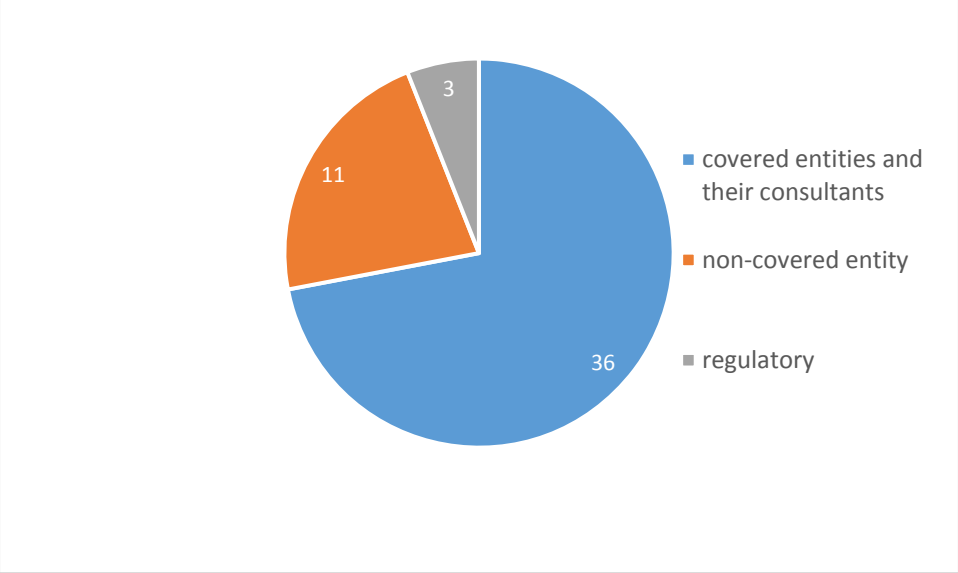


Figure 5. Workshop participant categories.

As expected, the majority of participation came from covered entities, who were the recipients of the targeted marketing efforts. In addition to covered entities, there were other Colorado systems, consultants and regulatory agencies in attendance.

There were a variety of disciplines represented at the workshops, with management, distribution and engineering as the most prevalent disciplines in attendance (Figure 6). The variety of department representation at the workshop is a success, as an effective NRW program is dependent on engagement from a variety of water departments. In every class, the participants were very engaged and intentional in the workshops. This observation is of interest, as in Colorado there is not currently a mandate for employing the M36 methods for water loss auditing and control. Thus the participants' level of engagement is a reflection of other drivers at work, including resource management, building customer trust and the direct financial benefits of water loss management to the utility.

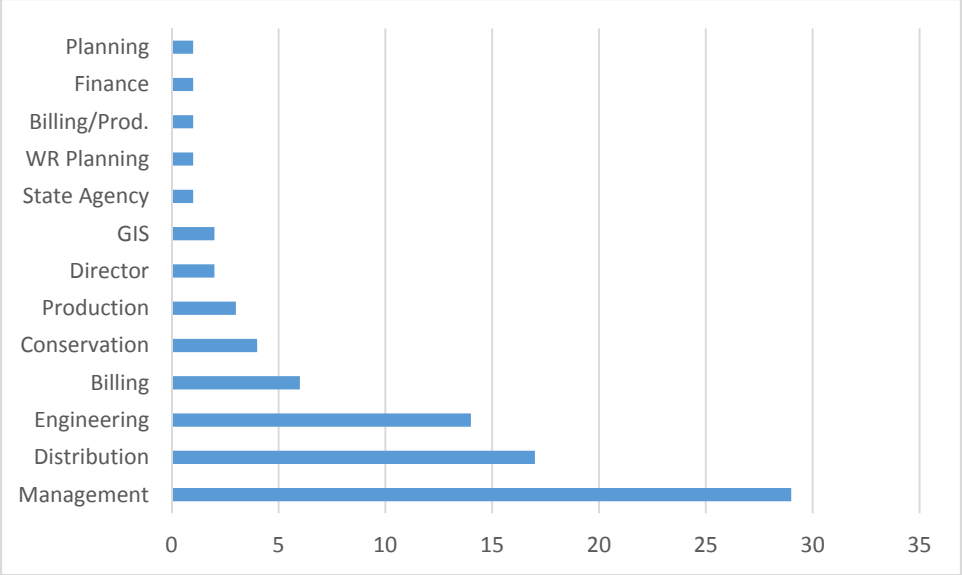


Figure 6. Utility disciplines in attendance.

NRW Concerns Survey Results

At the beginning of the workshop, participants were given a survey to determine awareness and concern relative to their current NRW practices. The participants were also asked to take the same survey again, at the end of the workshop. This was done as a measurement tool to gauge participant understanding and awareness in the concepts taught. The survey contained the following questions, with a ranking from 1-5, with 1 being “Not concerned at all” and 5 being "I've got to get that solved now":

1) *I am concerned that my Utility does not have a cross department NRW team that's meeting monthly, benchmarking results, and establishing next month objectives based on AWWA's M36 manual of practice for reduction of Non-Revenue Water.*
2) *I am frustrated that the information we are tracking does not appear to be valid and defensible and can vary widely from month to month.*
3) *I am concerned that our Non-Revenue Water is not specifically tracked by each component - real loss, apparent loss, and unbilled consumption (in terms of volumes and values) and thus I have no idea where to begin intervention.*
4) *I am concerned that we don’t test our finished water meters and don’t have high confidence in the total volume of water we are supplying into our system.*
5) *I am concerned that my Utility’s active leak detection program is not guided by a business case and economic level of intervention but rather on operator knowledge and speculation.*
6) *I am concerned that there is customer use not being billed or is being under-billed and that our current meter testing program is not economically optimized.*

The following graph represents participant responses to the concerns noted above, for all locations.

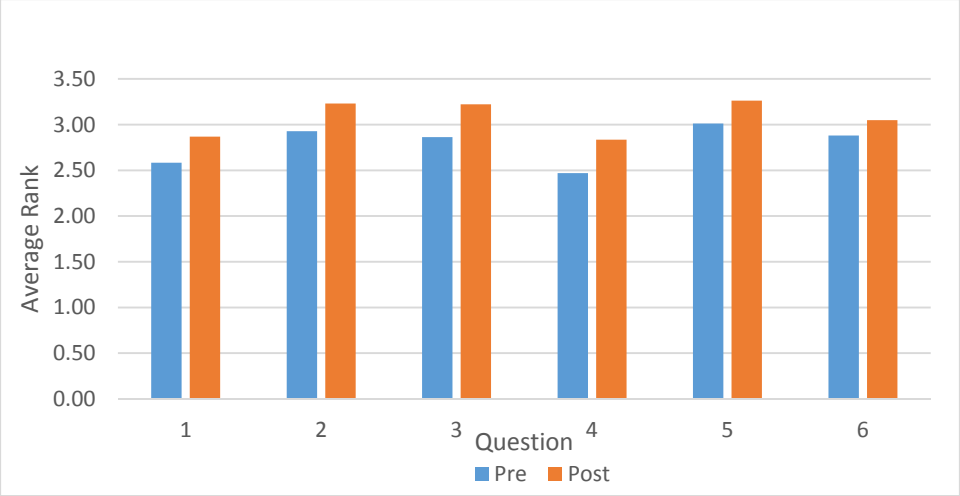


Figure 7. Pre- vs Post- workshop concerns survey.

As illustrated above, utility concerns relative to their current NRW practices can be found in all areas. A general increase in level of concern pre-workshop to post-workshop, is observed. This increase is influenced by an increased awareness of the issues with exposure to the workshop content.

Utility Feedback

At the end of the workshop, utilities were asked to complete an evaluation regarding the training. The following section summarizes the results of the completed evaluations. Utilities were very satisfied with the overall quality of the training program, with 98% of evaluation responses at a rating of good or very good. Furthermore the training met or exceeded expectations for 98% of participants.

Specific utility feedback on the training program is provided below to give perspective on the positive differing opinions on the effectiveness of the program:

- *"Provided very good overview of how to approach water loss. Using model in class was great. " (East Larimer County)*
- *"Instructor was deeply knowledgeable of how material applies to varying aspects of operations." (Eagle River)*
- *"Excellent presentation skills as well as useful takeaway materials." (Eagle River)*
- *"Despite not being super technical in this area, I really learned a lot. The content and instruction was high-quality, and the pace was spot on. " (SACWSD)*
- *"I was expecting to be bored due to information being over my head but was able to take a lot of useful information home with me." (Erie)*
- *"I have performed leak detection for 18 years but never knew where the info needs to go." (Greeley)*
- *"Instructors were professional, pleasant and interesting to hear them talk on the topic." (Westminster)*

Utilities were very pleased with the training and 92% of utilities plan to apply the information they learned at the training workshop, to their professional work and decisions. 8% of utilities are not quite sure yet how they will apply the training and learned concepts.

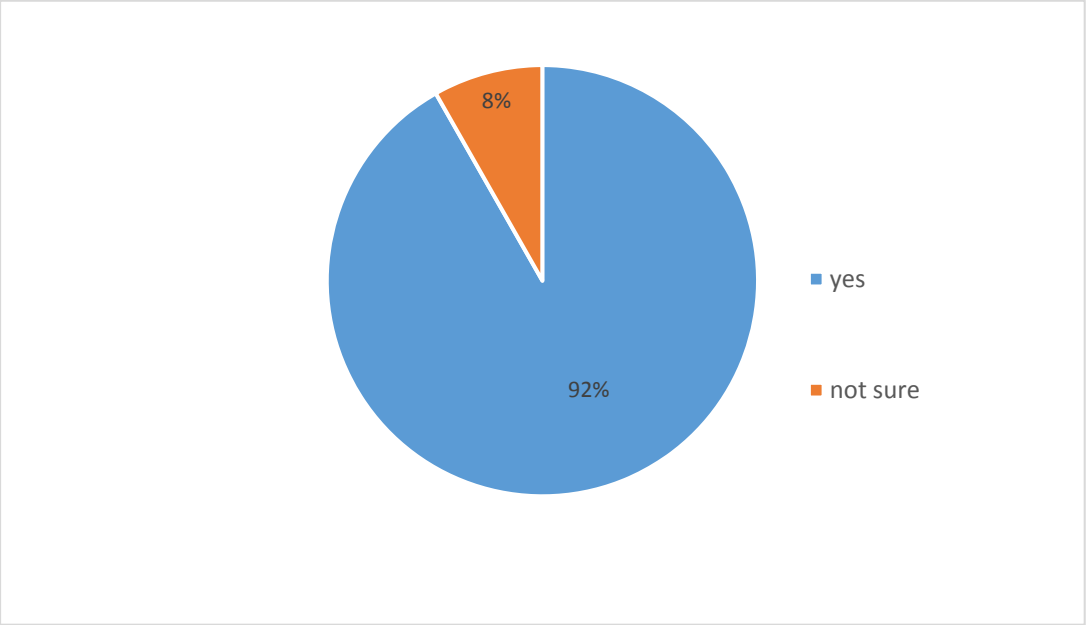


Figure 8. Indicated action to apply workshop knowledge.

Participants further indicated some of the ways they plan to apply the training they received. Several participants expressed that they will start performing an annual water loss audit and utilize the leakage component analysis model. Many others expressed specific actions such as starting a meter testing program. Here are some examples of some of the specific action that utilities are planning to apply their training through:

- *"Will calculate for a rate of rise on water loss and improve on understanding of data validity." (Eagle River)*
- *"Be able to track NRW instead of % water loss." (East Larimer County)*
- *"Update our M36 Data and use leakage component analysis to justify budget expenditures." (Eagle River)*
- *"Apply this information to provide more of business management solution for my company." (Cherokee Metro)*
- *"Documentation of size, type of leaks and pipes; work with worksheets to help department learn where we are for water loss." (Greeley)*

Furthermore, there was an overwhelming response from workshop participants indicating the desire for deeper and broader training. Here are some specific feedback examples of areas where participants foresee the need for deeper training:

- *"Need to focus on how to best motivate systems to get started. Getting a system to start doing it is critical. It needs to be emphasized how it will help them; some of the details can be a bit overwhelming. " (Todd Stonely, State Agency)*
- *"A little more discussion on the takeaways from the two models. The discussion was good, but more would be interesting/helpful. " (SACWSD)*

- *"Once you have moved from the spreadsheet how do you implement continuous improvement." (Fountain)*
- *"I learned a lot from the hands-on experience and more classes should be designed on hands-on." (Trinidad)*
- *Explained Audit components a little more clearly. Would have like just a little more on organizing 'team' for audit". (Russ Barros, State Agency)*
- *A specific example from the City of Pueblo, is attached to the end of the document.*

From the feedback received in the pilot program, it is evident that there is still a large need and desire for deeper training on these topics in Colorado. A follow on training program should focus on deeper application of the foundational concepts from the pilot program. This should include conducting the water audit, data validation and loss component analysis steps with each system using their own data. Implementation of a statewide training program would cultivate widespread adoption of best management practices for water loss, better resource management and standardization of water loss reporting to the AWWA M36 format.

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September 28, 2015

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Will -

I attended the September 23, 2015 session of the AWWA Pilot Training Program on water audits and loss control in Pueblo, Colorado. Ric Esgar, Pueblo Water's Division Manager of Transmission and Distribution, was my partner for the day's interactive sessions.

As noted during the session, a study conducted by the Water Research Foundation indicates more than 1 out of every 5 water loss audits conducted via AWWA-methodology present implausible water loss scenarios. The research also suggests the data used to populate these audits may not be accurate. These results show the great need for more training and education to improve confidence in water loss reporting.

As a Public Relations person whose responsibilities include conservation, I found the training to be both very accessible and very thorough. I began the day with a very general understanding of the topic of water loss measurement and prevention, but ended the day feeling well-grounded in the concepts of the audit process, data validation, and the component analysis that is required to achieve economically sound optimization of a transmission and distribution system.

Having done the homework that was assigned prior to the training, I approached the use of the M 36 Water Audit Tool with a degree of trepidation - the care and feeding of spreadsheets and their kin not being key aspects of my skill set. However, the well-designed and flexibly-delivered training exercises transported me through the process with a surprising amount of ease. I left the session feeling strongly that I can help my utility move toward a useful, believable assessment of its transmission and distribution system health.

We at Pueblo Water believe our water delivery system is in good shape and that we do a good job of controlling water loss. As increasing water demand spurred by statewide population growth strains the limits of our finite water supplies; as the variability of our climate may decrease the amount and significantly change the required management of those supplies; and as Colorado's Water Plan invokes water use efficiency as a major strategy in meeting these challenges, all water providers will be called upon to optimize their water systems and minimize real losses in these systems. This training program on AWWA M36 Water Audits and Loss Control will be a powerful tool to achieve this.

Thank you to all the sponsors for making such effective training available at a very reasonable cost.

Regards,

Paul Fanning
Public Relations and Legislation Administrator