The City of Montrose’s Water Audit Experience

David Bries, Utilities Manager
City of Montrose
And Project 7 Trustee
Outline

• Background information
• Water Conservation Plan
• M36 Water Audit
• Our Findings
• Next Steps
Background

- City of Montrose purchases its water from Project 7, a regional water supply entity.
- Service population ~ 19,000
- 7,600+ services
- Fixed Network meter reading system
  - Access to hourly usage data
- 150 miles of water mains
  - 60% PVC
  - 40% AC
  - <1% CI/DI
- ~5-10 main breaks annually
City of Montrose Water Conservation Challenges

• Water is viewed by community as plentiful, water rights exceed demands.
• Ag demands are much larger than Municipal Demands
• Municipal water usage is relatively low compared to others around the state
• Wholesale and Retail water charges have been very stable
• Recently installed a fixed network AMI system and in a 5 year meter replacement program
• Retail volumes very close to Wholesale purchases….low “Unaccounted for” water percentage
• …..So why are we interested in waterloss?
Water Conservation Plan

• Our Water Conservation Plan requires a Water Audit in accordance with AWWA M36.
• In early 2017 we issued a RFP and Contracted with Cavanaugh to perform the Water Audit.
Our Plan and Expectations

• City staff expected to find low amount of leakage due to few breaks and leaks.
• Recent meter replacement program should account for retail usage accurately.
• City staff had noted numerous times where monthly retail usage exceeded wholesale purchase volumes.
The M36 Audit Process

- Imported water data
- Meter reading data
- Retail water sales data
- Watermain and service line data
  - Length of pipe
  - Pipeline material
  - Break/leak records
- Meter testing and accuracy data
M36 - A Better Way to Look at Waterloss

• Quantifies Water Loss
• Differentiates between Real water loss and apparent water loss.
• Quantifies system leakage expectation
• Quantified meter inaccuracy volumes
So What Did We Learn?

• Retail metered volume is too close to wholesale volume to be realistic.
• Wholesale meter configuration is critical to accurately measuring water input
Findings

- Suspected wholesale meter is under-registering water due to vault & piping configuration.
- Test meter installed in a downstream air release connection appear to confirm.
- Evaluating options to improve site conditions to get better metering accuracy with Wholesale supplier.
- Potential Recoverable leakage is less than 5 million gallons per year.
Outcomes of M36 Water Audit

• Better understanding of importance of wholesale metering accuracy
• Better understanding of meter layout requirements to perform accurately
• Importance of Data validity
Summary

- Water Audit is a valuable tool to help identify and validate water losses.
- The details of the information collected are valuable.
- Having experienced consultant provides great insights and value, and adds credibility.
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Water Auditing Foundations
AWWA M36 Methodology

Will Jernigan, P.E.
Director of Water Efficiency
Chair, AWWA Water Loss Software
Secretary, AWWA Water Loss Control Committee
U.S. Appointee for ISO International Water Loss Standard
## Water Audit Report

**Water Audit Report for:**

**Reporting Year:** 2013, 1/2013 - 12/2013

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

### Master Meter Error Adjustments

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

### Authorized Consumption

**Billed metered:**

- 5
  - 700.0
    - MG/YR

**Billed unmetered:**

- 10
  - 50.0
    - MG/YR

**Unbilled metered:**

- 10
  - 10.313
    - MG/YR

**Unbilled unmetered:**

- 9
  - 10.313
    - MG/YR

### WATER LOSS (Water Supplied - Authorized Consumption)

**Unauthorized consumption:**

- 10
  - 3.000
    - MG/YR

**Customer metering inaccuracies:**

- 7
  - 7.071
    - MG/YR

**Systematic data handling errors:**

- 4
  - 5.000
    - MG/YR

**Apparent Losses:**

- 15.071
  - MG/YR

### Non-Revenue Water

**Non-Revenue Water:**

- 7
  - 75.000
    - MG/YR

### System Data

- **Length of mains:** 100.0 miles
- **Number of active AND inactive service connections:** 1.000
- **Service connection density:** 10
- **Average length of customer service line:** (length of service line, beyond the property boundary, that is the responsibility of the utility)
- **Average operating pressure:** 60.0 psi

### COST DATA

- **Total annual cost of operating water system:** $1,000,000
- **Customer retail unit cost (applied to Apparent Losses):** $3.50
- **Variable production cost (applied to Real Losses):** $3,000.00

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**Industry Standard (M36)**

**Free**

**Defaults provided**

~13 Volume Inputs
~7 System Data Inputs
The Water Balance

- Water Supplied
- Authorized Consumption
- Water Losses
- Unbilled Consumption
- Apparent Loss
- Real Loss
- Billed Consumption
- Non-Revenue Water
- Revenue Water
Apparent Loss – Categories

Unauthorized Consumption
- Theft!

Metering Inaccuracy
- Customer meter under registration

Data Handling Errors
- Reporting or other clerical errors during the handling of meter reading data
Real Loss – Categories

- **Background Leakage**: Unreported and un-detectable using traditional acoustic equipment.
- **Unreported Leakage**: Detectable using traditional acoustic equipment.
- **Reported Leakage**: Surfed and is reported by public or utility staff.
AWWA M36 Water Audit
Data Validity Scoring

In computer science, **data validation** is the process of ensuring that a program operates on clean, correct and useful data.

- AWWA developed a detailed grading matrix for Water Audit inputs
- Based on the utility’s policies and practices for data collection, data management, data archiving, quality control procedures, and derivation of audit inputs
- Provides a quantitative measure of the reliability
Grading Matrix

- Each criteria must be met to qualify for the data score
Water Loss Control

1. Determine Loss Volumes
   - AWWA water audit
   - Apparent & Real Loss volumes

2. Distinguish Types of Loss
   - breakdown of types of leakage
   - breakdown of types of Apparent Loss

3. Evaluate Economics
   - costs of losses
   - costs of intervention strategies
   - cost-benefit!

4. Implement Interventions
   - leak detection
   - repair time improvement
   - pressure management
   - meter optimization
   - revenue recovery
   - cost effective!
Wisconsin Pilot 6 systems, 6 months

Washington Pilot 10 systems, 9 months

Colorado Pilot 50 systems, 3 months

Utah Pilot 20 systems, 6 months

North & South Carolina Pilot 18 systems, 1 year

Arizona Pilot 6 systems, 6 months

California Full Scale 460 systems, 2 years

New Mexico Full Scale 134 systems, 1 year

Georgia Full Scale 230 systems, 5 years (and counting)

Hawaii Full Scale 100 systems, 4 years

Colorado Pilot 50 systems, 3 months

Wisconsin Pilot 6 systems, 6 months

North & South Carolina Pilot 18 systems, 1 year

Arizona Pilot 6 systems, 6 months

California Full Scale 460 systems, 2 years

New Mexico Full Scale 134 systems, 1 year

Georgia Full Scale 230 systems, 5 years (and counting)

Hawaii Full Scale 100 systems, 4 years
Water Auditing Foundations
AWWA M36 Methodology

Will Jernigan, P.E.
Director of Water Efficiency
Chair, AWWA Water Loss Software
Secretary, AWWA Water Loss Control Committee
U.S. Appointee for ISO International Water Loss Standard
PRESENTATION OUTLINE

• AWWA M36 WATER AUDIT & LOSS CONTROL PROGRAM – WHY NOW
• ASPEN’S WATER CONSERVATION & EFFICIENCY HISTORY
• WATER SYSTEM PARAMETERS & KEY ASSETS
• WHAT WE’VE DONE SO FAR
• PLANS FOR 2018 & BEYOND
• LESSONS LEARNED
ROARING FORK WATERSHED REGIONAL WATER EFFICIENCY PLAN

PARTICIPANTS:
CITY OF ASPEN
TOWN OF SNOWMASS VILLAGE
TOWN OF BASALT
TOWN OF CARBONDALE
CITY OF GLENWOOD SPRINGS
ESTIMATED ANNUAL REGIONAL WATER SAVINGS

400 TO 600 ACRE-FEET/YEAR BY 2050
130,340,600 TO 195,510,900 GALLONS/YEAR BY 2050

ESTIMATED CITY OF ASPEN ANNUAL WATER SAVINGS

32 TO 64 ACRE-FEET/YEAR BY 2050
10,000,000 TO 21,000,000 GALLONS/YEAR BY 2050

PROGRAM COST -- $10,000 – 1ST YEAR
## CITY OF ASPEN MUNICIPAL WATER EFFICIENCY PLAN

<table>
<thead>
<tr>
<th>Water Efficiency Activities</th>
<th>Sectors Impacted</th>
<th>Ongoing Activity?</th>
<th>Implementation Period of New Activities</th>
<th>Projected Water Savings 2015 - 2035 (AF/yr)</th>
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<tr>
<td><strong>FOUNDATIONAL ACTIVITIES</strong></td>
<td></td>
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<tr>
<td>Automatic Meter Reading Installation and Operation</td>
<td>All</td>
<td>YES</td>
<td>2014-2018 for existing &amp; ongoing for new customers</td>
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<tr>
<td>Enhanced Water Loss Control</td>
<td>All</td>
<td></td>
<td>annual</td>
<td>38</td>
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<td>Conservation-Oriented Rates</td>
<td>All</td>
<td>YES</td>
<td>2015 – rate structure update</td>
<td>145</td>
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<td><strong>TARGETED TECHNICAL ASSISTANCE AND INCENTIVES, AND NATURAL REPLACEMENT OF FIXTURES AND APPLIANCES</strong></td>
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<td>Fixtures, Appliances, and Incentives</td>
<td>All, Indoor</td>
<td>YES</td>
<td>Ongoing</td>
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<td>Outdoor Water Efficiency</td>
<td>All, outdoor</td>
<td>YES</td>
<td>Ongoing</td>
<td>20</td>
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<td>Slow the Flow</td>
<td>All</td>
<td>YES</td>
<td>Ongoing</td>
<td>30</td>
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<tr>
<td>Info and education, Farmer’s Market, xeriscape seminars, Efficient Parks, etc.</td>
<td>All</td>
<td>YES</td>
<td>Ongoing</td>
<td>40</td>
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<tr>
<td>Commercial, Institutional, and Industrial Water Efficiency</td>
<td>CII</td>
<td>YES</td>
<td>2015</td>
<td>70</td>
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<td><strong>ORDINANCES AND REGULATIONS</strong></td>
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<tr>
<td>Regulatory Measures</td>
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<td>YES</td>
<td>Ongoing</td>
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<tr>
<td>Water Reclaim and Recycling, Raw Water Irrigation</td>
<td>Irrigation</td>
<td>YES</td>
<td>Ongoing</td>
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<tr>
<td>Waste of Water Ordinance Update</td>
<td>All</td>
<td>YES</td>
<td>2015</td>
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<tr>
<td>Update landscape development regulations for new construction to place emphasis on water efficiency in residential development</td>
<td>SF &amp; MF residential</td>
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<td>2018</td>
<td>50</td>
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<td><strong>EDUCATIONAL ACTIVITIES</strong></td>
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<tr>
<td>Public information, customer outreach and education</td>
<td>All</td>
<td>YES</td>
<td>1992 - present</td>
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<tr>
<td>Community outreach event participation</td>
<td>All</td>
<td>YES</td>
<td>Before 2006 - present</td>
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<td>Utility billing inserts</td>
<td>All</td>
<td>YES</td>
<td>2008 - present</td>
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<tr>
<td><strong>TOTAL SAVINGS THROUGH 2035 (AF/YEAR)</strong></td>
<td>All</td>
<td></td>
<td></td>
<td>583</td>
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</table>
HISTORY OF CONSERVATION & EFFICIENCY MEASURES

- 1971 – Initiated Metered Service for Water Accounts
- 1992 – Start of Water Use Education and Outreach Programs
- 1994 – Applied to State for Water Conservation Program grants
- 1995 – Leak Detection Program Initiated for Mainlines and Service Lines
- 1996 – City approved its first Water Conservation Plan
- 1996 – Outcome Measures set for Unaccounted For Water
- 1997 – Freeze Up Program Eliminated
- 1998 – Movement of Treated water users to Raw water
- 2002 – Customer rebates for meeting summer use targets – Drought declaration
- 2006 – Conservation Rates established – 4 Tier System
- 2006 – Efficiency Division and Rebate Program established
- 2007 – Building Codes for Low Flush Toilets
- 2010 – Water Conservation resources added to Website
- 2012 – Online Drought Resources added to Website
- 2012 – Updated Water Shortage Ordinance
- 2013 – Partnered with Center for ReSource Conservation on Slow the Flow Program - Annual
- 2013 – Partnered with Center for ReSource Conservation on Gardens In A Box Program -- Annual
- 2014 – Tier Revisions approved by Council – 20% Tier Tightening effective 1/1/15
- 2015 – Adoption of Municipal and Regional Water Efficiency Plans
- 2017 – Adoption of Water Efficient Landscape Ordinance
- 2017 – Phase I of AWWA M36 Water Loss Audit
- 2017 – Start of Leak Detection Program – ½ complete as of year end
- 2018 – Increased Capital Infrastructure Budget by $1 Million Dollars per Year
KEY ASSETS & DELIVERY MECHANISMS

- 20 MGD Surface Water Filtration Facility
- 2 Main Sources – Castle & Maroon Creeks
- 3 Groundwater Wells
- 3,950 Water Services/Customers
- 100 Miles of Pipeline
- 15 Pump Stations
- 17 Storage Tanks
- 16 Pressure Zones
- 660 Fire Hydrants

AUDIT BOUNDARY

Diagram showing the water delivery system with stages for raw water, treatment, storage, and plant usage.
2017 Phase I Water Audit & Loss Control Program
MAIN FOCUS – NON REVENUE WATER

IWA/AWWA Standard Water Balance

- Own Sources
  - Total System Input
  - Water Supplied
    - (allow for known errors)
- Water Imported
- Water Exported
- Authorized Consumption
- Billed Authorized Consumption
- Unbilled Authorized Consumption
- Apparent Losses
- Real Losses

Revenue Water
- Billed Water Exported
- Billed Metered Consumption
- Billed Unmetered Consumption

Non-Revenue Water
- Unbilled Metered Consumption
- Unbilled Unmetered Consumption
- Unauthorized Consumption
- Customer Metering Inaccuracies
- Systematic Data Handling Errors
- Leakage on Mains
- Leakage on Service Lines
- Leakage & Overflows at Storage
WHAT WE’VE DONE SO FAR

- Meter Testing and Replacement for Treatment Facilities and Bulk Water Accounts – Aspen Ski Company and West Buttermilk
- Meter Replacement Program for Customer Owned Water Meters
- Water Leak Survey – ½ of Water Service Area completed
- PRV Maintenance and Leak Repair
- RFP for Advanced Metering Infrastructure (AMI) – will include Distribution Meter Installs and Monitoring
- New Program for Valving on Pump Stations and Storage Tanks
PLANS FOR 2018 & BEYOND

• Increased Capital Infrastructure projects - $1 Million Plus per Year over next 10 years
• Adoption of Source Meter Volumetric Testing and Calibration Program using Appendix A of AWWA Manual on M36
• Meter Testing Program for Water Customer Meters and Consideration of taking over Meter ownership through Ordinance revision
• Perform an in-depth inventory/analysis of all unmetered customers to perform account level consumption estimation
• Evaluate customers for confirmation that irrigation volumes are being metered
• Review account level billing anomalies and develop a systematic approach to tracking large volumetric adjustments
• Formally establish a Water Loss Coordinator to maintain responsibility for all data tracking, project management and reporting relative to NRW intervention strategies
• Continue Proactive Leak Detection Surveys on all Areas of the Distribution System
• Develop District Metering Area Pilot program with focus on Minimum Night Flow Analysis for Real Loss Management
• Develop Pressure Optimization Pilot program for reduction in break frequencies and background leakage component
PLANS FOR 2018 & BEYOND (CONTINUED)

- Installation of Meters on Filler Hydrants
- Timely Work Order Estimates of Water Loss for Leaks, Line Flushing and Hydrant Flushing rather than using M36 defaults
- Develop a Water Loss Control Committee within the organization with appropriate representation from applicable water divisions and conduct regular meetings led by Water Loss Coordinator
- Continue to implement data collection practices to conduct water balance on segments of overall system
- True Cost of Leakage Evaluation, which will include:
  - Wear and tear on equipment
  - System capacity expansion
  - Constrained demand during drought
  - Liability claims/Insurance premiums impact
  - Environmental impacts
  - Political impacts
- Non-Revenue Water Gap Analysis, which will include:
  - Evaluation of current practices and policies against best practices detailed in M36 Manual
  - Preliminary economic analysis to determine cost of current NRW program to establish preliminary business case and prioritization of NRW components
  - Development of NRW component mapping including:
    - Unbilled consumption
    - Apparent loss components—i.e. optimizing metering losses
    - Real loss components—i.e. optimizing unreported losses
LESSONS LEARNED TO DATE

- Need to address elevated levels of data inaccuracies
- Even with the completion of only Phase I of Water Audit, the M36 process has created an administrative and field staff push for increased capital infrastructure projects
- Water Loss and Proposed Efficiencies are now part of water staff’s focus and awareness
- City of Aspen Water Department has reenergized its Conservation programs specifically in tracking down Non-Revenue Water Losses
- Renewed focus on Best Management Practices as a Water Provider & Utility
- Advice to Other Water Providers—If you haven’t started the M36 Water Audit & Loss Control Program, YOU should start NOW!
CONTACT:

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Lee.Ledesma@cityofaspen.com

www.cityofaspen.com
Colorado Water Conservation Board Water Loss Initiatives

Kevin Reidy
State Water Conservation Specialist
Water Supply Planning
CWCB
Colorado’s Water Plan sets a measurable objective to achieve 400,000 acre-feet of municipal and industrial water conservation by 2050
Actions

Support water management activities for all water providers

Support local water smart ordinances

Carry out land use-water efficiency trainings

Incorporation of land-use practices into water conservation plans
Pilot M36 Workshops

CWCB teamed up with Colorado WaterWise, Rocky Mountain Section-AWWA, Water Research Foundation and Cavanaugh

One (1) introduction/overview webinar

Five (5) day-long workshops across the state in September 2015
Pilot M36 Workshops

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

• Utilize the Water Balance

• Separate Total Water Loss into Real and Apparent Loss

• Separate Real and Apparent Loss into their subcomponents

• Use metrics in units of Volume, Value & Validity

• Assess interest in more comprehensive statewide training
Colorado Water Loss Initiative

• Funded through the CWCB’s Projects Bill in 2017

• $1.1 million for ~2 years of statewide training

• American Water Works Association M36 Methodology

• Train water providers on state of the art methodology

• Similar to California and Georgia efforts
Training Process

• Level 1 validation of utility prepared water audits

• Multiple “touch points” for reinforced understanding

• Webinars and multiple workshops

• One on One technical assistance with experts

• Key is that participants will work through their own water audits and work iteratively with experts to ensure understanding and a valid analysis
Timeline

Scope of work is in State of CO procurement getting ready to generate an RFP

(Hopefully) April 2018 start date!
Planning for a Water Loss Audit

Andrea Schweitzer, PhD, PMP
Fort Collins Utilities
Also known as...
Tips to go along with AWWA’s 275-page M36 Manual
Why do an M36 audit?

- More data to track down
- More analysis work
- We already calculate NRW as a percentage of total water production
Reasons why:

• Recover more revenue
• Better understand our distribution system
• Save water
• Understand increases or decreases in water loss
Moving away from using water loss as a percentage of initial water supply.

A simple loss percentage is not always a meaningful metric.
Non-Revenue Water Percentage Variability

Example of Loss %
(not FCU data)
Data collection and data validation are like herding cats (or chasing dogs in a swimming pool)
Our official goals:

- State 1051 reporting
- Better understand distribution system
- Recover more revenue
Our unofficial goals: (but just as important!)

• Team-building
• Cross-training
• Knowledge transfer across departments, between facilities, and from experienced staff to newer staff
Valuable aspects:

- Core team attended a CWW day long training – very useful
- Grading – promotes good discussion
- Economic estimates from M36 SW – also helpful
Colleagues will help bail you out if needed

- Do check in with them and ask questions
- Allow time for review
- Share drafts and initial results for feedback
Thank you
• Andrea Schweitzer
• Renee Davis
• Chris Donegon

Questions?