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Water Research Foundation 4372a

Real Loss Component Analysis: A Tool for Economic Water Loss Control

WSI, October 2014

Project Team





WRF Project Review: #4372a

Effective Organization & Component Analysis of Utility Leakage Data

PROJECT BASICS:

- Funded by the WRF and EPA
- Model Release & Report Publishing in June 2014
- Webinar on June 19 2014

PROJECT GOALS:

- Provide utilities software model for component analysis of real losses
- Provide informative context for performance indicator results
- Develop the software model to optimize use (prioritizing accessibility and adoption)

PARTICIPATING UTILITIES:

- Eastern Municipal Water District
- Metro Water Services, Nashville TN
- Halifax Regional Water Commission
- City of Folsom Utilities Dept
- San Antonio Water System
- Lake Arrowhead Community Services District
- S. Central CT Regional Water Authority
- City of Phoenix Water Services Dept
- Austin Water Utility
- Water & Wastewater Authority of Wilson County

Downloading the 4372 Materials

www.waterrf.org, then search for 4372 or real losses



Water Audits and Real Loss Component Analysis - 4372

Completion Year 2013 Research Value \$544,023 Research Manager Maureen Hodgins Contractor Water Systems Optimization Inc.

The purpose of this project is to help the North American water industry design efficient and sustainable leakage control programs. The project has been divided into two segments. Real Loss Component Analysis: A Tool for Economic Water Loss Control (Order #4372a) provides water utilities with an analysis tool to better understand the sources of their real losses (reported, un-reported, or background) and a means of analyzing their economic intervention strategies. This project improves the quality of standard leakage component analysis and compliments the AWWA Water Audits and Loss Control Program (M36), 3rd edition. In addition to the research report, the project produced two spreadsheet tools: a Component Analysis Model and the Leak Repair Data Collection Guide, which are available on this project page under Project Resources/Web Tools. 4372a was published in June 2014. Analysis of U.S. Water Audits (Order #4372b) will provide a national snapshot of IWA/AWWA water audit results including key performance indicators and benchmarks and summarize state regulations as of 2013. Data sources include approximately 2,500 water audits submitted to the California Urban Water Conservation Council, Georgia EPA, Texas Water Development Board, Tennessee Comptroller of the Treasury, and the Delaware River Basin Commission from 2011-2013. 4372b will be available in Fall 2015. Research partner: EPA.

| Report Name | Report # | Available | Order Report | Download PDF | Executive Summary |
|--|----------|-----------|--------------|--------------|-------------------|
| Real Loss Component Analysis: A Tool for Economic Water Loss Control | 4372a | 5/30/2014 | | POF | |

Project Resources

B Webcasts (1)

L-What are the Best Economic Options for Managing Leakage?



-Leak Repair Data Collection Guide Component Analysis Of Real Losses Software Model

The AWWA Water Balance

| | | Billed | Billed Metered Authorized Consumption | REVENUE |
|--------|--------------|--------------------|--|---------|
| | Authorized | Consumption | Billed Unmetered Authorized Consumption | WATER |
| | Consumption | Unbilled | Unbilled Metered Authorized Consumption | NON- |
| SYSTEM | | Consumption | Unbilled Unmetered Authorized Consumption | REVENUE |
| INPUT | | | Consumption Metering Errors | VVAILIN |
| VOLUME | | Apparent Losses | Unauthorized Consumption | |
| | | | Systematic Data Handling Errors | |
| | Water Losses | | Leakage/Overflow at Reservoirs | |
| | | Pool Lossos | Leakage from Trunk Mains | |
| | | Redi LUSSES | Leakage from Distribution Mains | |
| | | | Leakage from Service Connections | |

KEY

TOOL

Water Loss Control Program Next Steps

With A Completed AWWA Water Balance:

Volume of Apparent Losses
 Volume of Real Losses
 Performance Indicators
 Data Validity Score

Remaining Assessments:

- Understanding of Real Loss Breakdown (where are these losses occurring? what types of leakage?)
- Evaluation of Cost-Effective Real Loss
 Intervention Strategies
- Cost-Effective Non-Revenue Water
 Reduction Strategies

Component Analysis of Real Losses





- Adoption of AWWA Free Water Audit Software & Importance of Data
 Validation
- Contextualized Performance Indicators
- Break Frequency Research

- Tools for developing water loss control strategies
 - ➡ Location & Response Time Improvement
 - ➡ Pressure Management
 - ➡ Proactive Leak Detection

Adoption of Software Methodology & Data Validation

- Review of statewide regulations and policies regarding water loss and the AWWA Free Water Audit software
- California Urban Water Conservation Council (CUWCC)
 - BMP 1.2: annual water audit submissions
 - Examined FY09-10 data

| CUWCC BMP 1.2 – 2010 Water Audit Data Set Vali | Set Validation Steps | |
|---|----------------------|------------|
| | Count | Percentage |
| Number of Utilities Reporting Water Audit Result | 130 | 100% |
| Number of Utilities Reporting Negative Water Losses | 5 | 4% |
| Number of Utilities Reporting ILI<1 | 36 | 28% |
| Number of Utilities Reporting ILI>20 | 3 | 2% |
| Number of Utilities Reporting Erroneous Infrastructure Data | 1 | 1% |
| | | |
| Final Data Set After Removal of Erroneous Water Audit Reports | 85 | 65% |

| Table 2.6 |
|--|
| CUWCC BMP 1.2 - 2010 Water Audit Data Set Validation Steps |

Contextualized Performance Indicators



Break Frequency Research



- Focus on Predictive Models
- Terminology
- Data Collection Completeness

Break Frequency Research

WaterRF 4372: Effective Organization and Component Analysis of Water Utility Leakage Data

| Water Audit: City of Austin, TX, USA, 2011 |
|--|
| INFRASTRUCTURE FAILURE FREQUENCY ANALYSIS |

| City of Austin | | |
|---|---------|--------------------------|
| Total Number of Mains Failures Reported for Water Audit: City of Austin, TX, USA, 2011 | 707 | |
| Total Length of Mains | 3,649.0 | (miles) |
| Failure Frequency City of Austin | 19.4 | (number / 100miles / yr) |
| Average Failure Frequency in North America Based on Literature Review - WaterRF 4372 | 25.0 | (number / 100miles / yr) |
| Failure Frequency for Optimized Distribution Systems (Friedman 2010) | 15.0 | (number / 100miles / yr) |



| Total Number of Service Connection Failures Reported for Water Audit: City of Austin, TX, USA, 2011 | 1,114 | |
|---|---------|--|
| Total Number of Service Connections | 211,839 | (service connections) |
| Service Connection Failure Frequency City of Austin | 5.3 | (number / 1000 service connections / yr) |
| AWWA Unavoidable Annual Real Losses (UARL) Component of Reported Service Line Failures | 2.25 | (number / 1000 service connections / yr) |
| Ratio of Failure Frequency to UARL Break Frequency | 2.3 | |



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Value to be entered by the user Value is automatically filled in/calculated by Model Recommended default value

7/11/2013

Participating Utility Insight

- Integrity and completeness of failure data
- Readiness of average utility
- Presentation of software as a TOOL not a REPORT!
- Estimation/assumption comfort

Component Analysis of Real Losses



Real Losses Calculation for Reported & Un-Reported Leakage

Annual Real Loss Volume from Reported Leaks =

*# of leaks by size * average run time * average flow rate (at average system pressure)*

| Leakage Occurrence | Pipe Diameter | # of Events | Flow Rate (gpm) | Average Run Time (hrs) | Annual Leakage (MG) |
|-----------------------|------------------|----------------|--------------------|------------------------------|---------------------------|
| Mains Breaks | 8" | 6 | 46 | 8.25 | 3.3 |

Failure Repair Records

Estimated based on pipe size using BABE methodology

Awareness Time Estimation + Failure Repair Records for Location & Repair Time

Component Analysis of Real Losses

WaterRF 4372: Effective Organization and Component Analysis of Water Utility Leakage Data

Water Audit: City of Austin, TX, USA, 2011 REAL LOSSES COMPONENTS CHART



Leakage Management Strategies



Proactive Leak Detection Model



Pressure Management in the Model

Pressure Management Opportunities

| | Existing Pressure Management Policy | |
|---------------------------------|-------------------------------------|---------|
| Current Average System Pressure | 77.3 | PSI |
| Total Annual Real Losses | 4,332.2 | MG/Yr |
| Value of Real Losses | 1,429,630 | \$/year |

FAVAD N1 Value Used for Calculation of Real Loss Reduction Due to Reduction of Average System Pressure

| | O Use Default N1 | 1.0 |
|--|--------------------------|-----|
| | O Use System Specific N1 | 0.7 |
| Enter % of rigid pipes and service connections in system | 100% | |
| ILI | 3.0 | |

| | Alternative Pressure Management Policy | |
|--|--|---------|
| Assumed Reduction in Average System Pressure | 5.0 | PSI |
| Assumed % Reduction in Average System Pressure | 6% | |
| Real Loss Volume Saved Through Alternative Pressure Management Policy | 203.1 | MG/Yr |
| Value of Real Loss Volume Saved Through Alternative Pressure Management Policy | 67,026 | \$/Year |
| | | |
| | | |
| Enter Estimated Cost of Implementing Alternative Pressure Management Policy | 100,000 | \$ |
| Simple Payback Period for Implementing Alternative Pressure Management Policy | 1.5 | Years |

Response Time Improvement

| Failures on Mains | R | eported | Unrepo | orted | |
|---|----|---------|--------|-------|----------|
| Total Number of Failures on Mains in 2011 | | 707 | | 1 | |
| Average location and repair duration | | 1.4 | | 1.0 | days |
| Total Volume lost (stemming from location and repair duration) | | 153.9 | | 0.1 | (MG) |
| Total Cost of Volume lost (stemming from location and repair duration) | \$ | 50,785 | \$ | 23 | |
| What IF Location and Repair Duration is Reduced to | | 1 | | 0.5 | days |
| Percent Reduction | | 28% | | 50% | |
| Potential Related Savings in Leakage Volume | | 42.7 | | 0.0 | (MG) |
| Potential Related Savings in Leakage Volume Cost | \$ | 14,085 | \$ | 11 | |
| Service Line Failures | R | eported | Unrepo | orted | |
| Total Number of Failures on Service Connections in 2011 | | 1,114 | | 11 | |
| Average location and repair duration | | 1.4 | | 2.0 | days |
| Total Volume lost (stemming from location and repair duration) | | 16.3 | | 0.2 | (MG) |
| Total Cost of Volume lost (stemming from location and repair duration) | \$ | 5,374 | \$ | 76 | |
| What IF Location and Repair Duration is Reduced to | | 1 | | 1 | days |
| Percent Reduction | | 29% | | 50% | |
| Potential Related Savings in Leakage Volume | | 4.65 | | 0.1 | (MG) |
| Potential Related Savings in Leakage Volume Cost | \$ | 1,535 | \$ | 38 | |
| Failures on System Appurtenances | R | eported | Unrepo | orted | |
| Total Number of Failures on System Appurtenances in 2011 | | 1,867 | | 127 | |
| Average location and repair duration | | 17.2 | | 49.0 | days |
| Total Volume lost (stemming from location and repair duration) | | 25.2 | | 33.4 | (MG) |
| Total Cost of Volume lost (stemming from location and repair duration) | \$ | 8,323 | \$ 1 | 1,013 | |
| What IF Location and Repair Duration is Reduced to | | 1 | | 1 | days |
| Percent Reduction | | 94% | | 98% | |
| Potential Related Savings in Leakage Volume | | 23.8 | | 32.7 | (MG) |
| Potential Related Savings in Leakage Volume Cost | \$ | 7,838 | \$ 1 | 0,788 | |
| Total Potential Savings if Location and Repair Duration is Reduced as | | 192.2 | | 32.0 | (MG) |
| Simulated in the Above Sections | | 102.3 | | 52.9 | |
| Total Potential Cost Savings if Location and Repair Duration is Reduced as Simulated in the Above Sections | \$ | 23,458 | \$ 10 |),837 | Per Year |

Summarized Component Analysis

| WATER AUDIT PERFORMANCE INDICATORS | | |
|---|-------------|--------------------------|
| Financial | | |
| Non-revenue water as percent by volume of water supplied: | 10.3% | |
| Non-revenue water as percent by cost of operating system: | 3.0% | |
| Annual cost of Apparent Losses: | \$4,376,956 | |
| Annual cost of Real Losses: | \$1,429,630 | |
| Operational Efficiency | | |
| Apparent Losses per service connection per day: | 13.7 | gal/service conn/day |
| Real Losses per service connection per day*: | 56.0 | gal/service conn/day |
| Real Losses per length of main per day: | N/A | gal/mi/day |
| r service connection per day per 1787.62743734595 pressure: | 0.7 | gal/service conn/day/psi |
| Unavoidable Annual Real Losses (UARL): | 1,453.52 | MG/Yr |
| Current Annual Real Losses (CARL): | 4,332.21 | MG/Yr |
| Infrastructure Leakage Index (ILI) [CARL/UARL]: | 3.0 | |

| REAL LOSS COMPONENT A | NALYSIS RESULTS | | | |
|---|--------------------|----------------------|------------------------|----------|
| System Component | Background Leakage | Reported Failures | Unreported Failures | Total |
| | (MG) | (MG) | (MG) | (MG) |
| Reservoirs | 22.08 | - | - | 22.08 |
| Mains and Appurtenances | 372.61 | 217.12 | 173.49 | 763.22 |
| Service Connections | 844.15 | 39.55 | 17.46 | 901.15 |
| Total Annual Real Loss | 1,238.83 | 256.66 | 190.95 | 1,686.44 |
| Real Losses as Calculated by Water Audit | | | 4,332.21 | |
| Hidden Losses/Unreported Leakage Currently Running Undetected | | | 2,645.77 | |

| AWARNESS, LOCATION AND REPAIR TIME REDUCTION RESULTS | | | |
|--|-----------|------------|----------|
| | Reported | Unreported | |
| | Failures | Failures | |
| Total Potential Savings if Location and Repair Duration is Reduced as Simulated on the A-L-R Times Options Sheet | 182.3 | 32.9 | (MG) |
| Total Potential Cost Savings if Location and Repair Duration is Reduced as Simulated on the A-L-R Times Options Sheet | \$ 23,458 | \$ 10,837 | Per Year |

| ECONOMIC INTERVENTION FREQUENCY FOR PROACTIVE LEAK DETECTION RESULTS | | | |
|--|----------|---------|--|
| Percentage of the System to be Surveyed per Year | 31 | % | |
| Average Annual Budget for Intervention (Proactive Leak Detection) | 283,187 | \$/year | |
| Potentially Recoverable Leakage | 1,787.63 | MG/year | |

| ALTERNATIVE PRESSURE MANAGEMENT SCENARIO RESULTS | | |
|--|---------|---------|
| User-Inputted Reduction in Average System Pressure | 5.0 | PSI |
| Assumed % Reduction in Average System Pressure | 6% | |
| Estimated Real Loss Reduction from Pressure Management Program | 203.1 | MG/Yr |
| Financial Savings from Pressure Management Program | 67,026 | \$/Year |
| | | |
| User-Estimated Cost of Pressure Reduction | 100,000 | \$ |
| Resulting Pressure Management Program Payback Period | 1.5 | Years |

Please be in touch!

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Stay Tuned:

Upcoming Workshops

Nov. 4 Fort Worth

Nov. 5 Austin

Nov. 6 Los Angeles