

Water Loss Symposium August 22, 2013



Water Loss

Dr. Robert E. Mace Texas Water Development Board





Austin is Losing Three Billion Gallons of Water a Year



(alamosbasement/Flickr)

<u>KVUE reports</u> that thanks to broken and leaky pipework, Austin is losing three billion gallons of water a year, a particularly striking number given the area's formidable <u>drought conditions</u>. Ironic, too, given how vigilant the city is about <u>enforcing water restrictions</u>—Austin Water is known to send out crews in the middle of the night to photograph proof of improper watering.

"When we're in a drought, and we're asking people to conserve water and do their part, it sends a really bad



Home

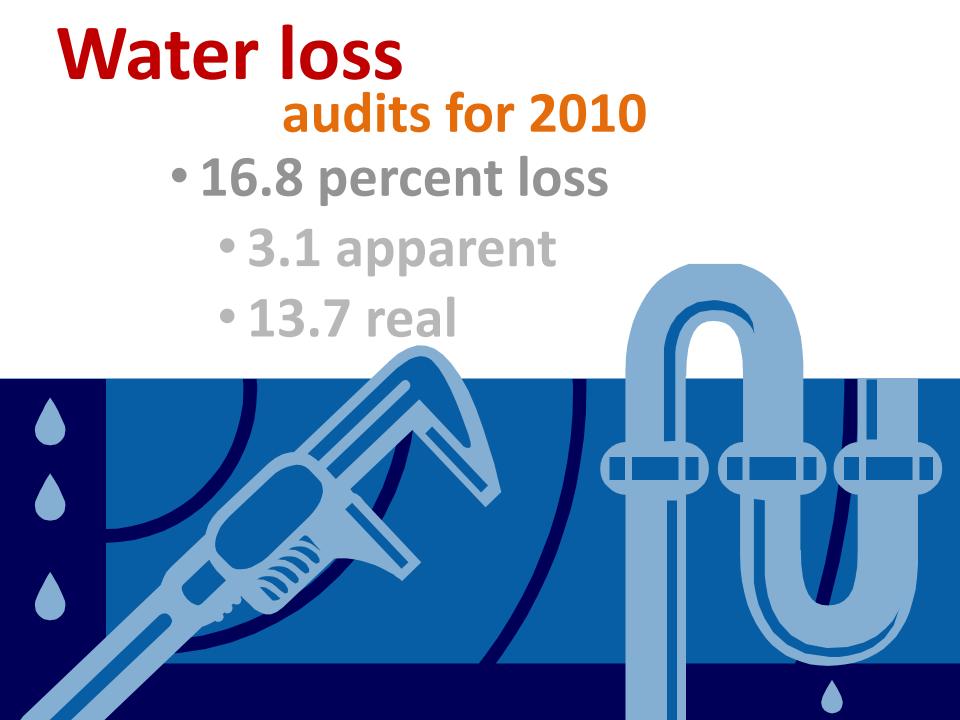
3 billion gallons of water lost



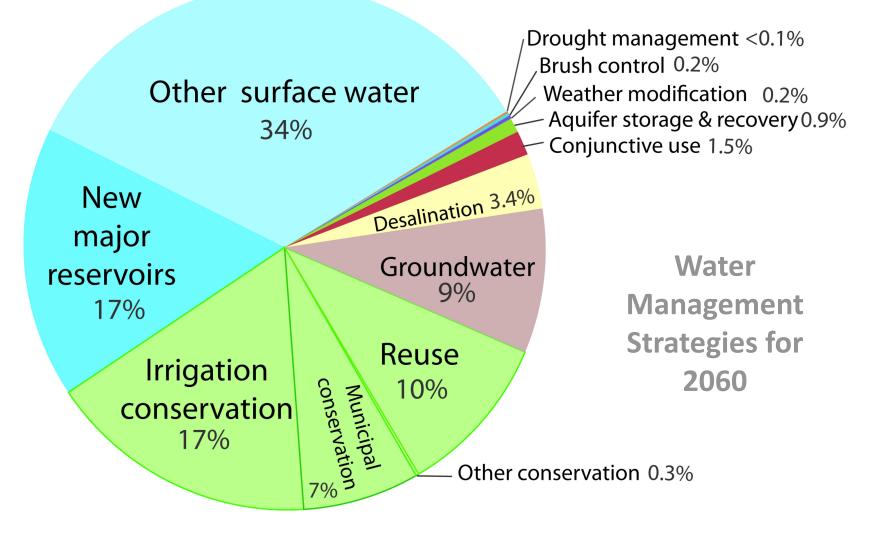
by ANDY PIERROTTI / KVUE News and photojournalist DEREK RASOR Bio | Email | Follow: @AndyP_KVUE

kvue.com Posted on August 19, 2013 at 10:38 PM Updated yesterday at 7:28 AM

AUSTIN -- A KVUE Defenders investigation uncovers the city of Austin loses more than three billion gallons of water a year due to leaky or broken pipes. It's happening during one of the worst droughts in Texas' history too.











WATER BALANCE 101: PROCESS & BENEFITS OF A WATER AUDIT

Water Loss Symposium August 22, 2013 TEXAS WATER DEVELOPMENT BOARD

KATE GASNER – PROJECT MANAGER WATER SYSTEMS OPTIMIZATION, INC.





Water Systems Optimization, Inc.

About WSO:

- Highly specialized in water loss assessment and management
- Acknowledged as one of the leading water loss control companies in North America

WSO

- Carried out many successful water loss control contracts for water utilities across North America and South East Asia
- Offices in Nashville, TN and in San Francisco, CA
- Implemented numerous Water Loss Control programs and trainings throughout the United States:
 - Philadelphia Water Department
 - Los Angeles Department of Water and Power
 - Metro Water Department (Nashville, TN)
 - Eastern Municipal Water District
 - City of Folsom
 - San Francisco Public Utilities Commission
 - California Urban Water Conservation Council
 - Phoenix Water Department

Non-Revenue Water



REAL LOSSES



APPARENT LOSSES

Benefits of NRW Management



- Comprehensive understanding of your system
- Financial Benefits Reduction in O&M & CIP costs
- Better Asset Management
- Optimized Meter Replacement/Management
- Water Conservation (Supply Side & Demand Side)
- Sustainability (Water/Energy Nexus)
- Be Ahead of Regulatory Arena
- Less Liability
- Build Credibility with Stakeholders and Regulators

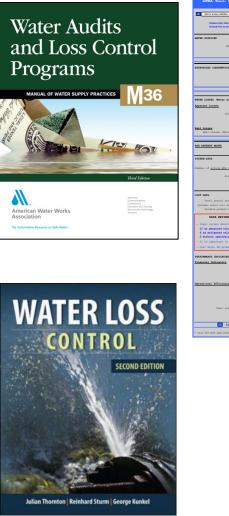
History - AWWA Water Audit Methodology

- Method published in 2000 by IWA Water Loss Task Force, with AWWA participation
- AWWA WLCC recommended IWA Water Balance and Performance Indicators (2003)
- New M36 Manual (Third Edition) published by AWWA (2009)
- AWWA Free Water Audit Software developed to accompany M36 Manual (currently version 4.2)

Best Practice Tools for Water Loss Control

AWWA M36 Publication

- Water Audits and Loss Control Programs (2009), 3rd Edition features the IWA/AWWA Water Audit Methodology
- AWWA Water Loss Control Committee's Free Water Audit Software[©]
 - Current version is 4.2 in English and French languages
 - Includes data grading capability
 - Companion "Compiler" Software
- Water Research Foundation Reports
 - Project 4372: Leakage Component Analysis is underway
- Textbooks
- www.awwa.com type "water loss control" in search box; select first item in list



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Average operating pressure:	2 12.0 ft	and controller meter or property
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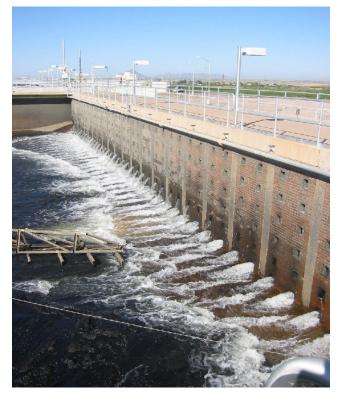
AWWA Water Audit

SYSTEM		
INPUT		
VOLUME		

Water Audit Tasks – Critical Data Validation

Challenge Accuracy of System Input Meters

Volumetric Meter Test



Comparative Meter Test



AWWA Water Audit

	Authorized Consumption
SYSTEM INPUT VOLUME	

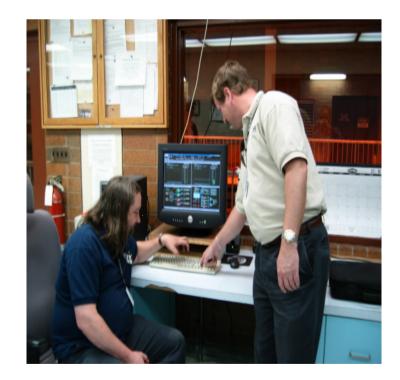
AWWA Water Audit

	Authorized	Billed Authorized Consumption	Billed MeteredAuthorized ConsumptionBilled UnmeteredAuthorized Consumption
	Consumption		
SYSTEM INPUT VOLUME			

Water Audit Tasks – Critical Data Validation

- Validate Billing Data Accuracy
 - Second most significant volume that flows into AWWA water balance
 - Two components:
 - Billed metered consumption
 - Billed unmetered consumption

• Validation is crucial



Water Audit Tasks – Critical Data Validation

- Billing Data Export:
- Typical billing data fields to be included:
- Customer identification fields
- → Meter identification fields
- → Service type identification fields
- → Meter read and consumption fields – units
- → Trouble codes or flags

- Validation Efforts
 - Confirm relevant consumption volumes
 - Confirm integrity of consumption → look for duplicates and irregularities

AWWA Water Audit

	Authorized	Billed Authorized Consumption	Billed Metered Authorized Consumption Billed Unmetered Authorized Consumption
	Consumption	Unbilled Authorized Consumption	Unbilled Metered Authorized Consumption Unbilled Unmetered Authorized Consumption
SYSTEM INPUT VOLUME			

Validation of Consumption Volumes

- Additionally all components of unbilled metered and un-metered consumption need to be assessed
 - Street cleaning
 - Mains flushing
 - **Fire fighting**
 - etc.
- Generally small portion of the "water supplied" volume
- If data is not available, do not spend lots of time on quantifying this value
- Instead, use the default value for "Unbilled Unmetered Consumption"
- Improve data validity over time



AWWA Water Audit

	Authorized	Billed Authorized Consumption	Billed Metered Authorized Consumption Billed Unmetered Authorized Consumption
	Consumption	Unbilled Authorized	Unbilled Metered Authorized Consumption
		Consumption	Unbilled Unmetered Authorized Consumption
SYSTEM INPUT VOLUME			
	Water		
	Losses		

AWWA Water Audit

	Authorized Consumption	Billed Authorized Consumption	Billed Metered Authorized Consumption Billed Unmetered Authorized Consumption
		Unbilled Authorized Consumption	Unbilled Metered Authorized Consumption Unbilled Unmetered Authorized Consumption
SYSTEM			Consumption metering errors
INPUT		Apparent Losses	Unauthorized consumption
VOLUME			Systematic Data Handling Errors
	Water Losses		

Apparent Losses from Small Meters

Meter Size	Meter Population	Test Sample Size	Volume-Weighted Average Accuracy	95% Confidence Limit of Accuracy
5/8"	13,548	66	92.0%	4.0%
3/4"	1,392	10	100.0%	0.4%
1"	2,145	20	96.9%	4.2%
1-1/2"	311	5	94.0%	3.8%
2"	391	13	97.6%	1.7%



Water Audit Tasks – Critical Data Validation

Task: Assess Customer Meter Accuracy

Meter size	Total volume supplied through meters during audit period (MG)	Average accuracy based on meter test results	Apparent Losses during audit period (MG)
5/8"	691.532	92.0%	59.725
3/4"	94.104	100.0%	-
1"	314.740	96.9%	10.136
1-1/2"	133.960	94.0%	8.535
2"	295.894	97.6%	7.214
Total	1,530.230		85.610



AWWA Water Audit

	Authorized Consumption	Billed Authorized Consumption	Billed Metered Authorized Consumption Billed Unmetered Authorized Consumption
		Unbilled Authorized Consumption	Unbilled Metered Authorized Consumption Unbilled Unmetered Authorized Consumption
SYSTEM INPUT VOLUME	Water Losses	Apparent Losses	Consumption metering errors Unauthorized consumption Systematic Data Handling Errors
		Real Losses	Leakage/overflow at service reservoirsLeakage from trunk mainsLeakage from distribution mainsLeakage from service connections

Water Balance Result

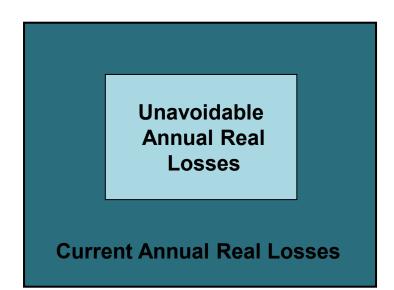
AWWA WLCC Fr	ee Water Aud	it Software:	Water Balance	Water Audit Report For:	Report Yr:
c	Copyright © 2010, American \	Water Works Association. All F	Rights Reserved. WAS v4.2	Philadelphia Water Department	2012
	Water Exported 5,483.700			Billed Water Exported	
			Billed Authorized Consumption	Billed Metered Consumption (inc. water exported) 48,987.000	Revenue Water
Own Sources (Adjusted for known		Authorized Consumption	48,987.000	Billed Unmetered Consumption	48,987.000
errors)		50,184.800	Unbilled Authorized Consumption	Unbilled Metered Consumption 0.000	Non-Revenue Water (NRW)
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				Systematic Data Handling Errors	
Water Imported		Water Losses 30,381.900		3,746.100 Leakage on Transmission and/or Distribution Mains	
			Real Losses	Not broken down	
0.000			22,563.600	Leakage and Overflows at Utility's Storage Tanks	
				Not broken down Leakage on Service Connections Not broken down	

Performance Indicators

AWWA Recommended Performance Indicators

- Real Losses/service conn/day
- Apparent Losses/service conn/day
- Infrastructure Leakage Index (ILI)

ILI = CARL/UARL



Thank You!

Kate Gasner

kate.gasner@wsoglobal.com 415.533.0419



THE ECONOMICS OF WATER LOSS CONTROL

Water Loss Symposium August 22, 2013 TEXAS WATER DEVELOPMENT BOARD

REINHARD STURM, VICE PRESIDENT WATER SYSTEMS OPTIMIZATION, INC

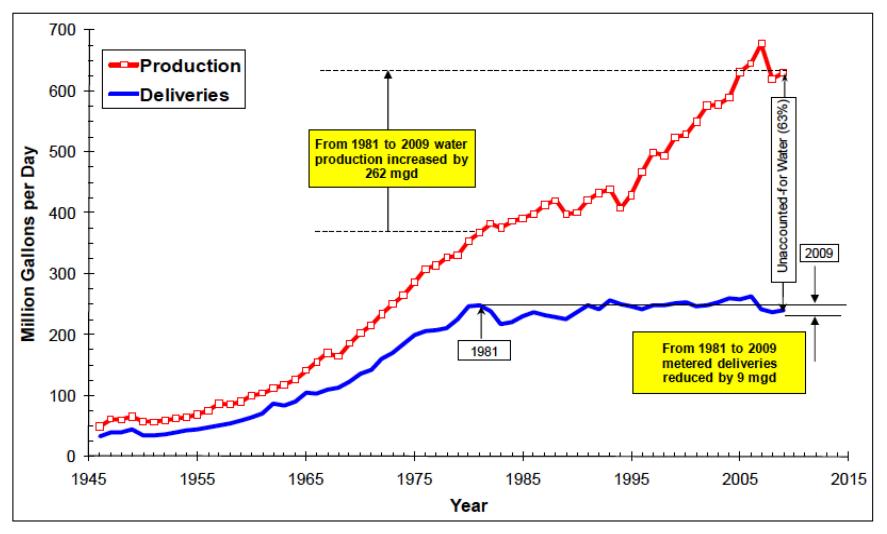




What Is Non-Revenue Water (NRW) ???

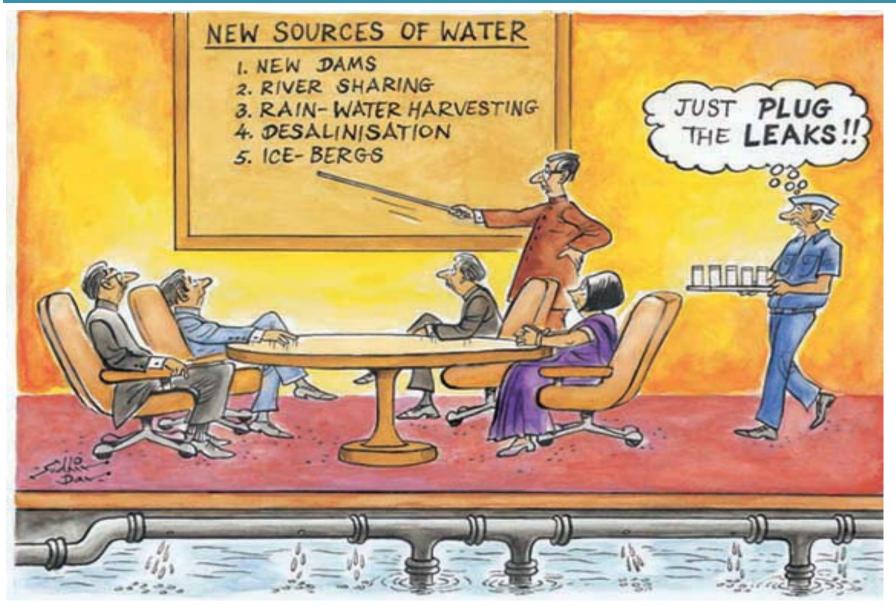


What Can Happen ???



Source: PRASA.

What is the Right Strategy?????



Source: World Bank Institute

What Is Non-Revenue Water (NRW)

Non Revenue Water consists of:

Real Losses



Apparent Losses



Apparent Losses



Reducing <u>Apparent</u> Losses increases revenue but creates no *new* water

- Apparent Losses are often referred to as "paper losses"
- This type of loss is where the most money can be recaptured
- Revenue Generation needs to be OPTIMIZED

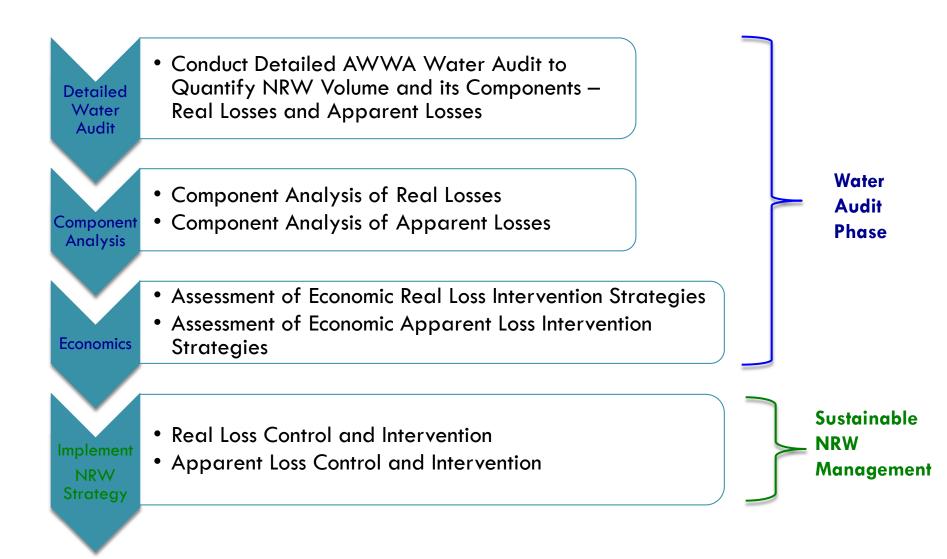
Real Losses



Real Losses

Reducing <u>Real</u> Losses creates an additional resource which reduces operating costs and can be used to defer capital expenditure

How Can We Strategically Manage NRW??



Non-Revenue Water Management Success Stories

Philadelphia Water Department

- Real Loss Reduction in 11 Years
 - 15,000 MG = \$1.6M Savings
- Apparent Loss Reduction in 11 Years
 - **\$15**M
- City of Phoenix Apparent Loss Reduction
 One Meter Make 745MG/Year
 Savings \$2.4M

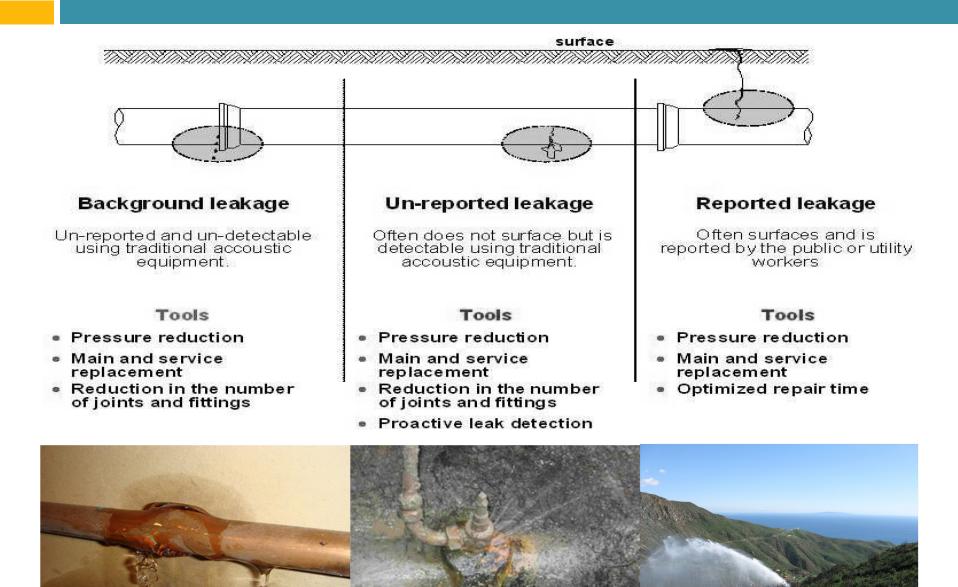
Non-Revenue Water Management Success Stories

City of Folsom – 2year Water Loss Control Program
 Real Loss Savings ~ 4MGD = \$700K/year

Permanent Water Loss Monitoring Implemented

- City of Panama City
 - Reduction of customer meter inaccuracy
 - Increased Revenue \$615K/year

Understanding The Components of Real Losses



WaterRF Research Project 4372 Model

- Extension of AWWA Free Water Audit Software (data easily transferable)
- Allows for basic Economic Assessment of Real Loss Control Options





WaterRF 4372

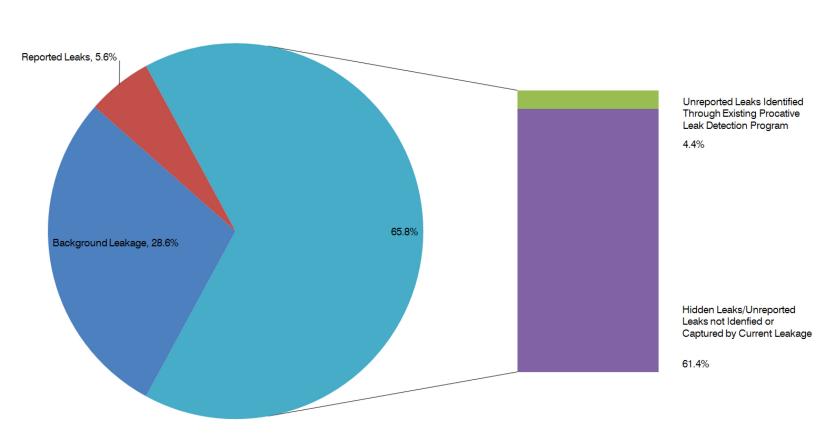
Effective Organization and Component Analysis of Water Utility Leakage Data Water Audit: City of Austin, TX, USA, 2011 MAIN MENU

Start Page	Enter the audit period and select reporting units
Summary	Summary of the water audit performance indicators and the results of the Real Losses Compoenent Analysis
AWWA Water Balance	Enter the required data from the AWWA WLCC Free Water Audit Software: Reporting Sheet to populate the Water Audit
Performance Indicators	Select your desired water loss performance indicator to be displayed in comparison to a North American water utility data set
Real Loss Components	Carry out a Real Losses Component Analysis using this sheet
RL Components Chart	A chart summarizing the results in the Real Loss Component Analysis
Break Frequency	Comparison of your utility's mains and service line break frequencies against industry averages and targets
A-L-R Times	Use this sheet to evaluate if a reduction in location and repair times for reported and unreported leaks would provide an opportunity to reduce real losses
Economic Intervention	Use this sheet to establish a preliminary schedule for proactive leak detection surveys
Pressure Management	Use this sheet to evaluate if pressure management and a reduction in average system pressure provides an opportunity to reduce real losses cost effectively
Glossary	Gossary of all terms used in the WaterRF 4372 Component Analysis Model
License	License

Understanding The Components of Real Losses

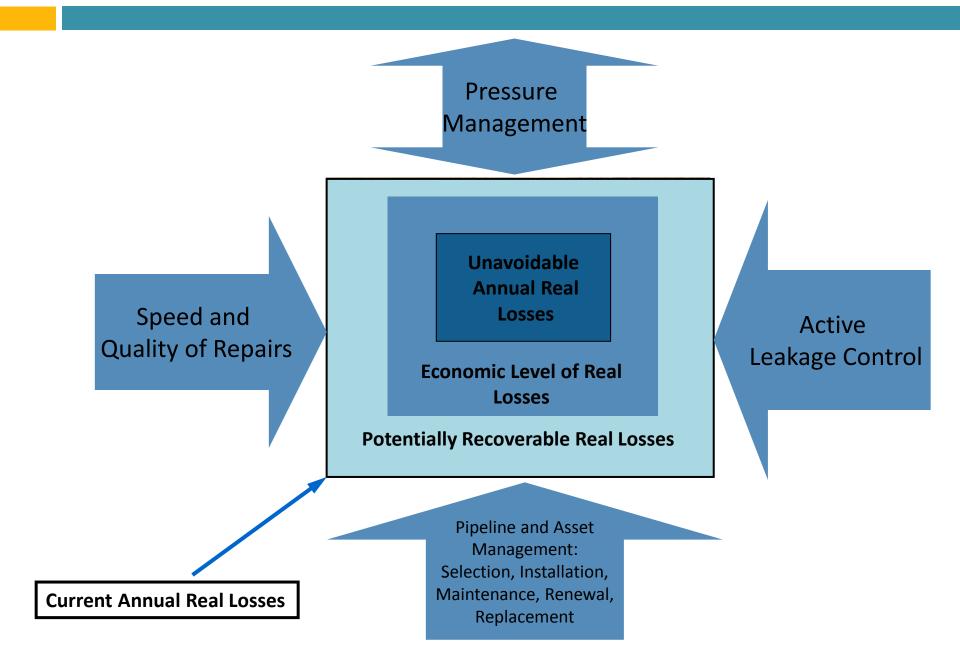
WaterRF 4372: Effective Organization and Component Analysis of Water Utility Leakage Data

Water Audit: FY11 REAL LOSSES COMPONENTS GRAPH

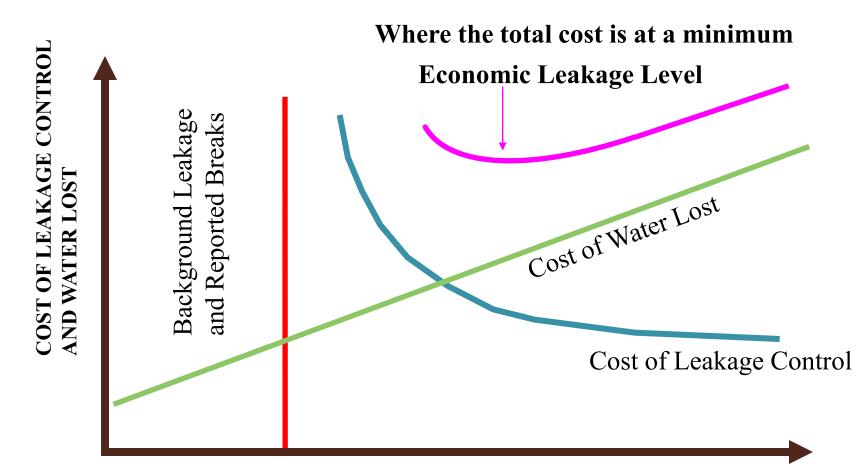


Real Loss Components

Management Tools for Real Loss Reduction



What Volume of Real Losses is Economic ??



LOSSES (MGD)

PWD System Wide Economic Level of Leakage for

Proactive Leak Detection

	Marginal Cost Valuation of Real Losses
Economic Intervention Frequency	36.3 month
% of System to be Surveyed Annually	33%
Annual Budget for Intervention	\$285,686
Economic Unreported Real Losses	1,245 MG/Year
Potential Recoverable Leakage	2,595 MG/Year



Economic Level of Leakage

- Real losses have real value they are a hidden cost for the utility
- Leakage control is primarily an operational cost
- The economic optimum is achieved when the combined cost of real losses plus the cost of leakage control is at a minimum

Thank You!

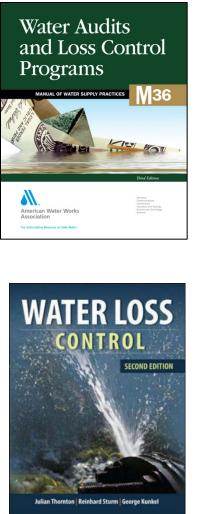
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NON REVENUE WATER	
	NCM-REVENUE WATER: 31,476.0 million gallons (UT) per year
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	Connection density: Average length of private pipe: t t 22:0 t density: t density:
	Average operating pressure: 2 2 53.0 psi
COST DATA	
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	Bio-revenue water as percent by volume: Bio-revenue water as percent by costs Accusic cost of Apparet boards Annual cost of Apparet boards Annual cost of Real Losses 53,945,748
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Real	losses per service connection per day per pai pressure: 2.41 pallons/connection/day/pai Unavoidable Annoal Real Losses (DAE): 5.98 million callons/day
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Benefits of NRW Management

- Identify what you don't know
- Financial Benefits Reduction in O&M & CIP costs
- Better Asset Management
- Optimized Meter Replacement/Management
- Water Conservation (Supply Side & Demand Side)
- Sustainability (Water/Energy Nexus)
- Be Ahead of Regulatory Arena
- Less Liability
- Build Credibility with Stakeholders and Regulators



TEXAS WATER AUDIT DATA

Water Loss Symposium August 22, 2013 TEXAS WATER DEVELOPMENT BOARD



STATE OF THE STATE BY: AND REW CHASTAIN-HOWLEY



STATE UPDATES

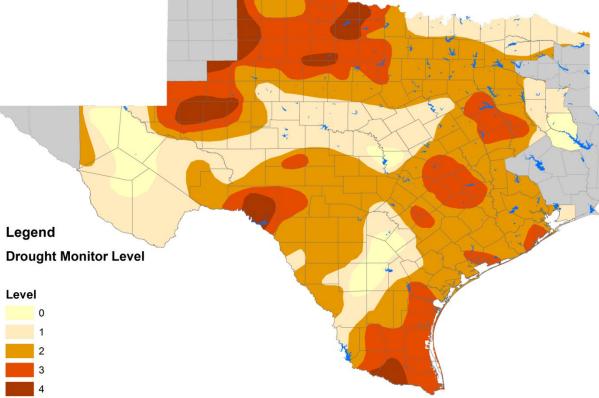
2011 Drought

 Led to significant re-evaluation of water resources and water use in Texas

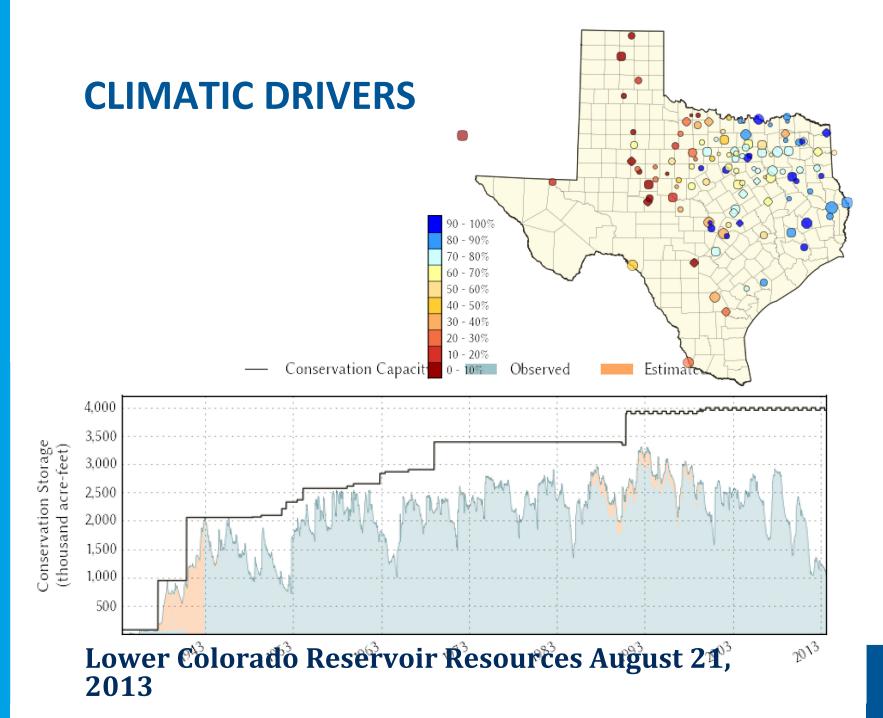
State Legislation

- Significant additions to water audit regulations
 - All utilities supplying more than 3,300 customers need to develop a water audit annually
- \$2 Billion Rainy Day Fund to be used (if voters approve in November) for loans to improve water resource situation.
 - Includes at least 20% for conservation which could include water loss reduction programs

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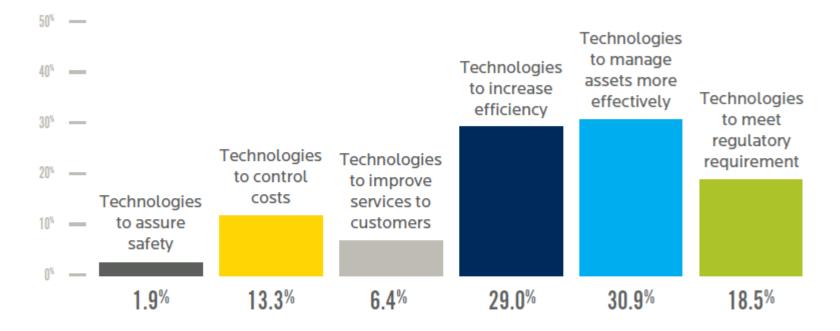
Drought Monitor July 2013



WATER UTILITY INFRASTRUCTURE CONCERNS

2012 Water Industry Survey:

Nearly 60% of responders said technology to increase efficiency and to manage assets more effectively will be the areas given the most emphasis in the future



Source: Black & Veatch

CURRENT RESOURCES



Water Loss Audit Manual for Texas Utilities by Mark Mathis • George Kunkel, P.E. • Andrew Chastain Howley



Texas Water Development Board



- Water Audit web-portal
- Water Audit Manual
- Review of 2006 Water Audit Data
- Water Audit Section at TWDB
- Water Audit Data Analyses

	P.O. E	WATER DEVEL 30X 13231, CAF AUSTIN, TX 78	ITOL STATION		
		2012 Water	Audit Report		
A. Water Utility General	Information				
1. Water Utility Name:	4 J River Way				
2. Contact:					
2a. Name					
2b. Telephone #					
2c. Email Address					
3. Reporting Period:		From _	1/1/2012	То	12/31/2012
4. Source Water Utiliza	tion, percentage:	Surface Water	0	% Ground Water	0 %
5. Population Served:					
5a. Retail Population	on Served			0	Assessment
5b. Wholesale Pop	ulation Served			0	Scale
6. Utility's Length of Ma	in Lines, miles			0.00	0
7. Number of Wholesal	e Connections Se	rved		0	

THE FIRST SET OF DATA IN 2005

FINAL REPORT

AN ANALYSIS OF WATER LOSS AS REPORTED BY PUBLIC WATER SUPPLIERS IN TEXAS



A RESEARCH PROJECT Funded by A Research and Planning Fund Grant from the

TEXAS WATER DEVELOPMENT BOARD



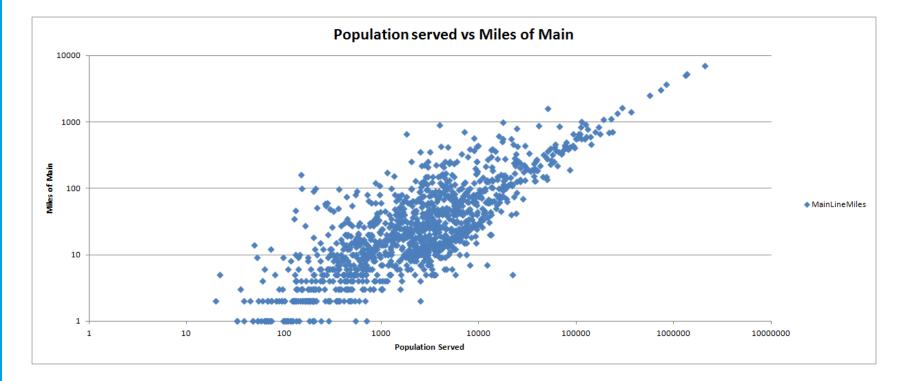
- Approximately half of retail public utilities in Texas reported their water loss data.
- Reporting utilities served as much as 84 percent of the state's population.
- A substantial amount of water (the balancing adjustment) was not attributed to any water use category, causing significant uncertainty in estimates of water loss and non-revenue water.

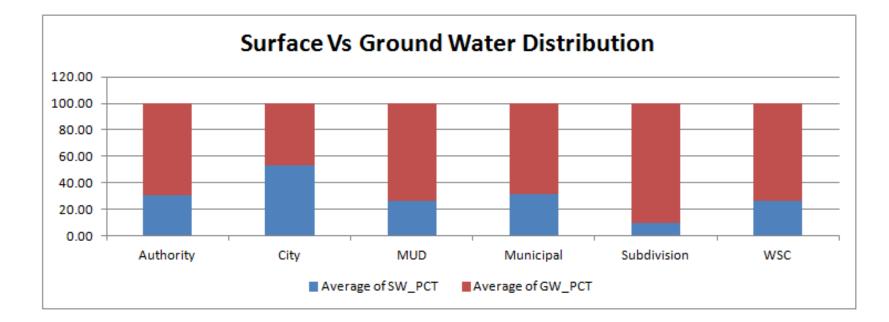
DATA EVALUATIONS FROM 2005.

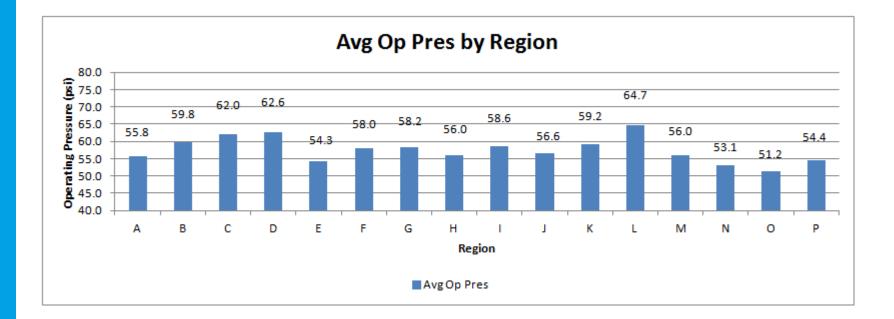
Table 1-1: Statewide Totals of Reported Water Loss* (acre-feet)

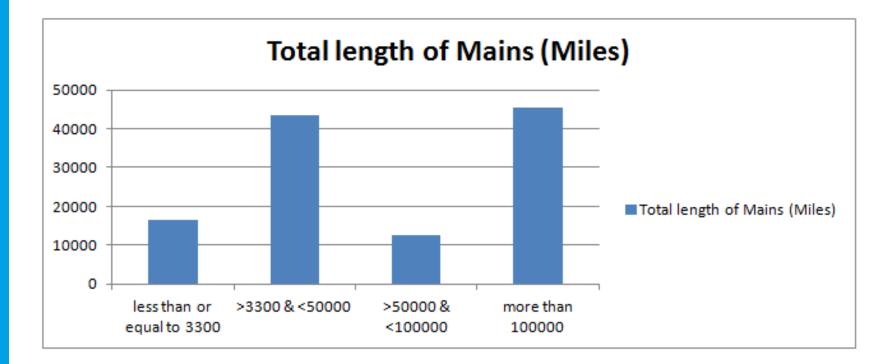
Corrected input volume (3,758,484)	Authorized consumption (3,294,265)	Billed authorized consumption (3,195,153)	Billed metered consumption (3,190,972) Billed unmetered consumption (4,181)	Revenue water (3,195,153)
		Unbilled authorized consumption	Unbilled metered consumption (52,698) Unbilled unmetered consumption	-
		(99,112)	(46,414)	
	Water losses (212,221)	Apparent losses (109,310)	Unauthorized consumption (10,770)	
			Customer meter under-registering (87,218)	Non-revenue water
			Billing adjustment and waivers (11,322)	(311,333)
			Main breaks and leaks (83,529)	
		Real losses (102,910)	Storage overflows (3,341)	
			Customer service line breaks and leaks (16,040)	
		Bal	ancing Adjustment** (251,998)	

* Over approximately one year. Most utilities reported data for calendar or fiscal year 2005

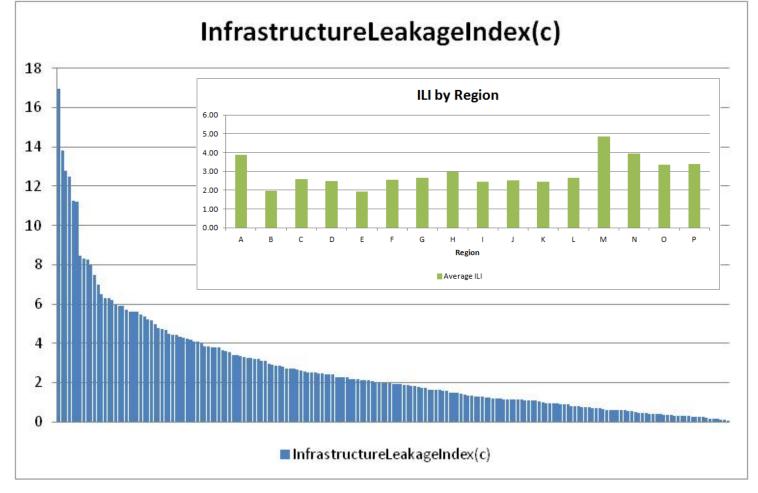




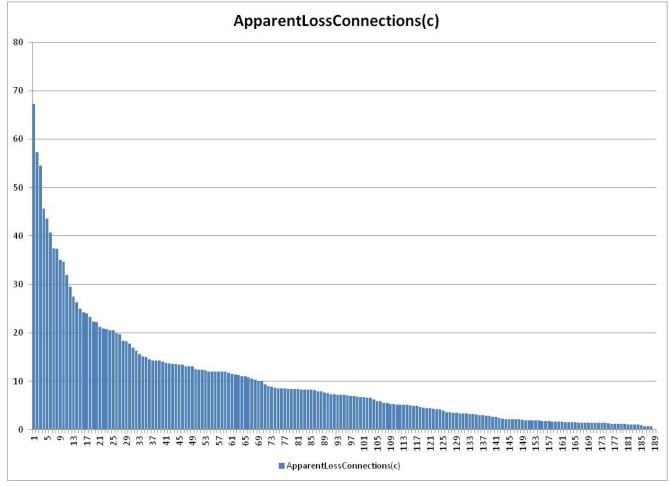




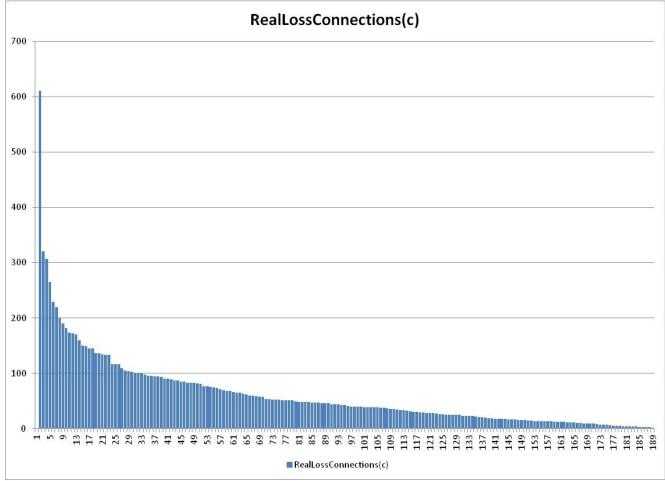
INFRASTRUCTURE LEAKAGE INDEX



APPARENT LOSS



REAL LOSS



Water Loss Reduction Implementation Manual

Report¹

by Andrew Chastain-Howley, M.Rhil, P.G. Malcolm Brandt B. Eng (Hons), C.Eng, FICE, FCIWEM, MIWater, Rupa Taa Michaelle Combrell B. Eng (Hons), C.Eng, MCIWEM, C.WEM, MAPM, MIWater John Stuton Joan Moran-Loper

Texas Water Development Board P.O. Box. 13231, Capital Station Austin, Texas 78711-3231 8014



FUTURE WATER LOSS REDUCTION RESOURCES

- Water Loss Reduction Implementation Manual (2014)
- AWWA Resources
- WRF Projects
- Water Conservation Division help
- Rainy Day Fund Loans?



WATER LOSS REDUCTION IMPLEMENTATION MANUAL

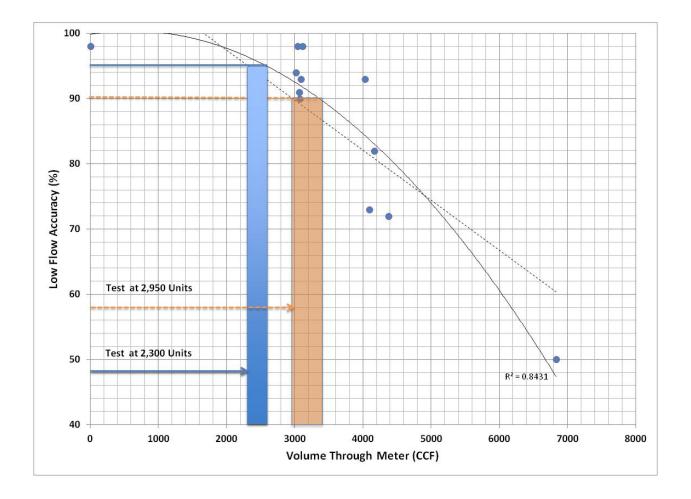
- Due to be completed early 2014
- Will provide information to all sizes of systems for implementing water loss reduction programs
- Details for apparent loss and real loss programs
- Discussion of benchmarks and data ranges

11.2	
56.5	
1,932	
	56.5

LEAK DETECTION EVALUATION METHODS



METER ACCURACY EVALUATION METHODS

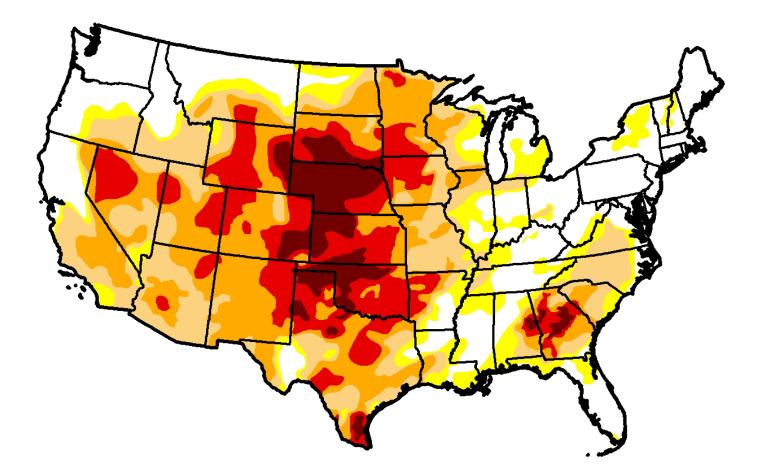


NATIONAL WATER AUDIT DATA INITIATIVES

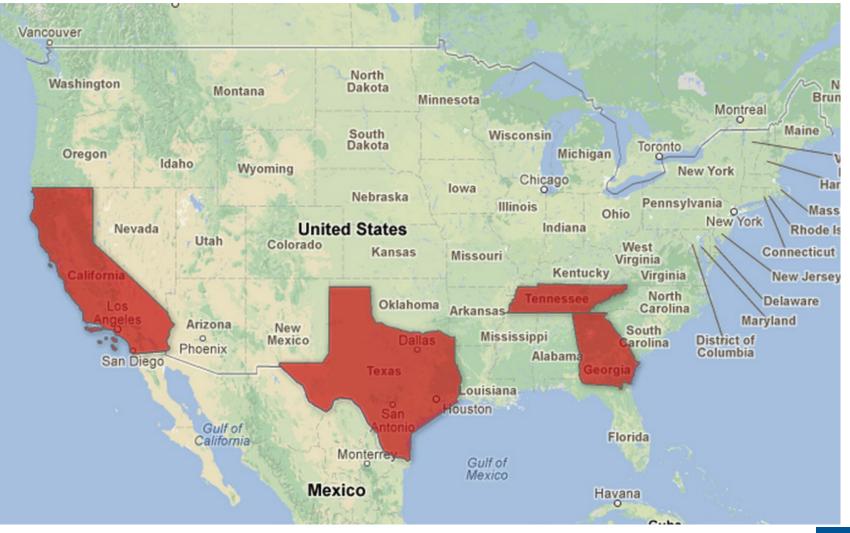
WHAT ELSE IS GOING ON



ENVIRONMENTAL DRIVERS



REGULATORY DRIVERS



STATE OF GEORGIA

- Decades long struggle for use of water from Lake Lanier; 2009 court ruling went against the City of Atlanta's continued level of withdrawals for water supply
- Landmark *Water Stewardship Bill* passed March 18, 2010: requires IWA/AWWA water audit by all water utilities by 2013
- Metropolitan North Georgia Water Planning District: part of Atlanta Regional Commission; oversees +60 water utilities in multi-county Atlanta area
 - Requires water utilities to submit water audits via AWWA Free Water Audit Software[©]
 - Developed training program around the software



www.legis.ga.gov/legis/2009_2010/pdf/sb370.pdf www.northgeorgiawater.com/files/WSWC_SECTION8.PDF

DELAWARE RIVER BASIN COMMISSION PENNSYLVANIA PUBLIC UTILITY COMMISSION

♦DRBC revised its Water Code in March 2009 to incorporate the IWA/AWWA Water Audit Method and AWWA Free Water Audit Software©

Collecting water audits – initially on a volunteer basis - mandatory by 2012

 PA PUC launched pilot water audit program in 2010 with five companies employing AWWA
 Free Water Audit Software©:

- Pennsylvania-American Water
- Aqua Pennsylvania
- **United Water**
- **York Water Company**
- Superior Water Company

The two agencies are sharing resources in launching the water audit programs





BACKGROUND:

- BMP1.2 Water Loss Control Program (10years)
 - First four years focus on data validation and water loss accounting
 - Second phase to establish benchmarks and improvements to water loss performance
- Six two-day workshops provided between 2010 and 2012 plus a webinar
- WSO received the first data set of water audits for data validation



2010 and 2011 Water Data Analysis and Validation:

• Simple steps of data validation were applied

	Count	Percent of Full Data Set
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%

Results highlight the problems utilities are facing when completing an audit for the first time!

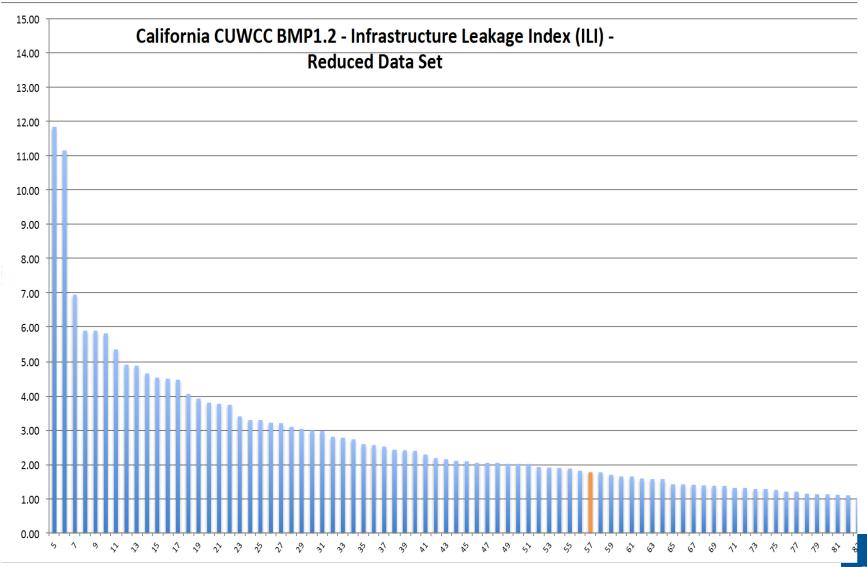
2010 Water Data Analysis and Validation:

- 35% report implausible results
- Data Validity is an issue more training and outreach needed

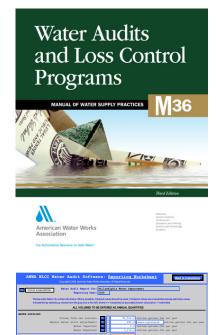
However:

- Average data validity score 75.6 (Level IV = 71-90)
- Average data validity score of utilities reporting negative water losses 77.0
- 51% of utilities report length for service pipe curb stop to meter
- Financial data reported often questionable
- Especially system input volume and consumption volumes need to be validated

Note: Texas Water Audit Data showed similar data quality issues – 52% of water audits are technically impossible!!!!



AWWA NATIONAL WATER AUDIT DATA INITIATIVE



AWWA	TOOLS	FOR	WAT	ER
LOSS CC	NTROL			

- The "M" Series: Manuals of Practice
 - Guidance Manuals: widely recognized around the world as source of best practices in water utility operations and management
- AWWA Water Loss Control Committee's Free Water Audit Software©
 - Originally released 2006; current Version 4.2 software (2010)

VALIDATION METHODOLOGY

• Primary Focus : "Validation" over "Outputs"

 Assuring valid data, rather than finding the system with the "lowest" losses

• Validation process – standardized by the WLCC:

- A validation checklist of questions was developed to guide the validation telephone interviews
- Conference call interviews conducted with utility representatives
- Water audit inputs and gradings modified where deemed appropriate
- Utilization of AWWA "Compiler" software developed for the management of water audit data from multiple utilities

USE FOR TEXAS UTILITIES

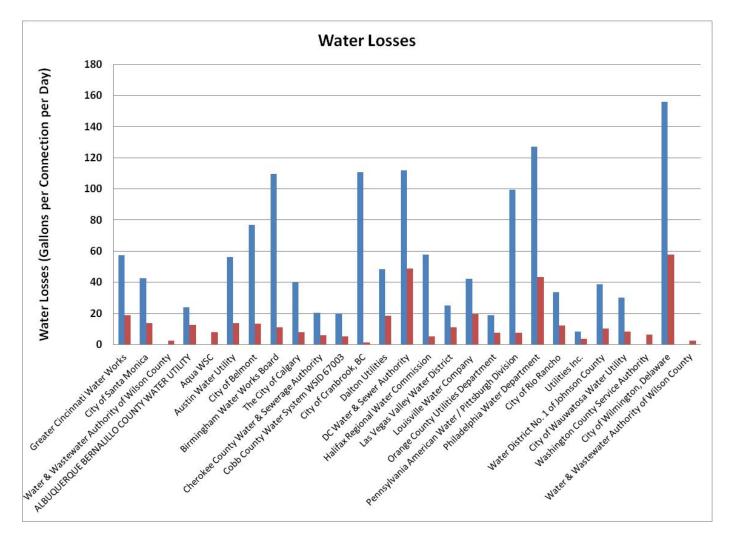
• National Data from Recognized Utilities

- First set of data that puts a name to a dataset
- Useful in benchmarking against similar utilities (size, location, losses...)
- Useful in helping determine a value for difficult to determine inputs and to make sure data is within a reasonable range

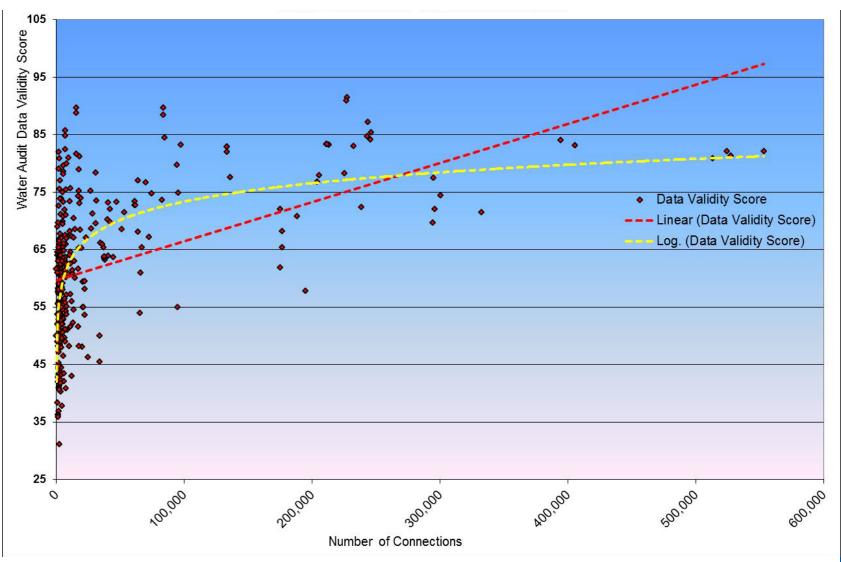
Standard Process and Documentation

• Aids with auditing for the Texas Audit as the procedures and data inputs required are very similar

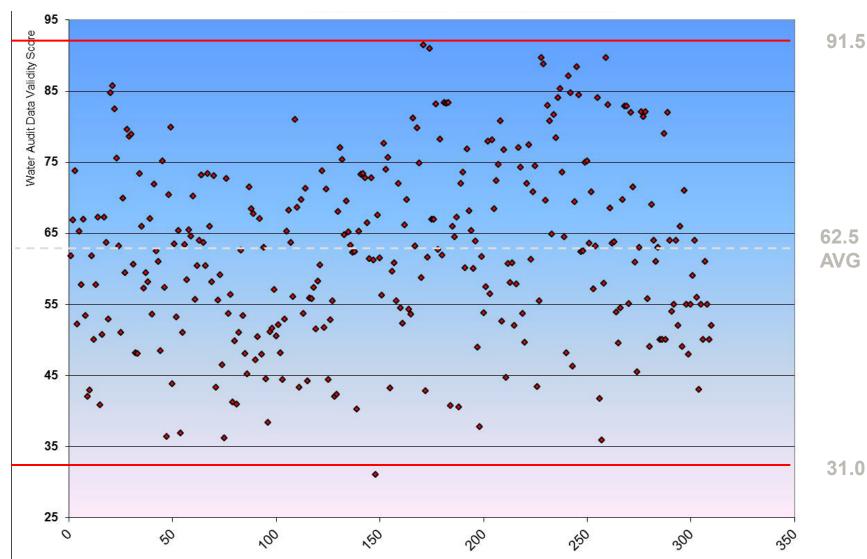
OVERALL WATER LOSSES



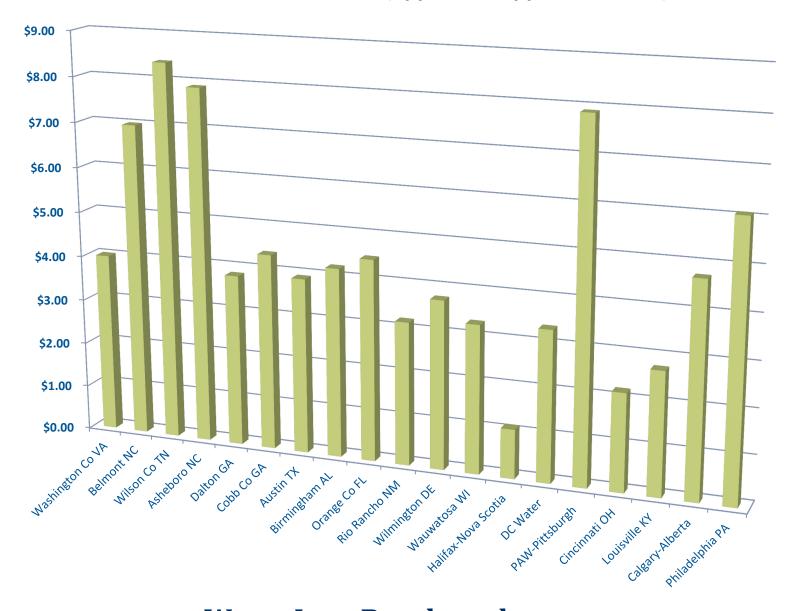
DATA VALIDITY VS SYSTEM SIZE



DATA VALIDITY

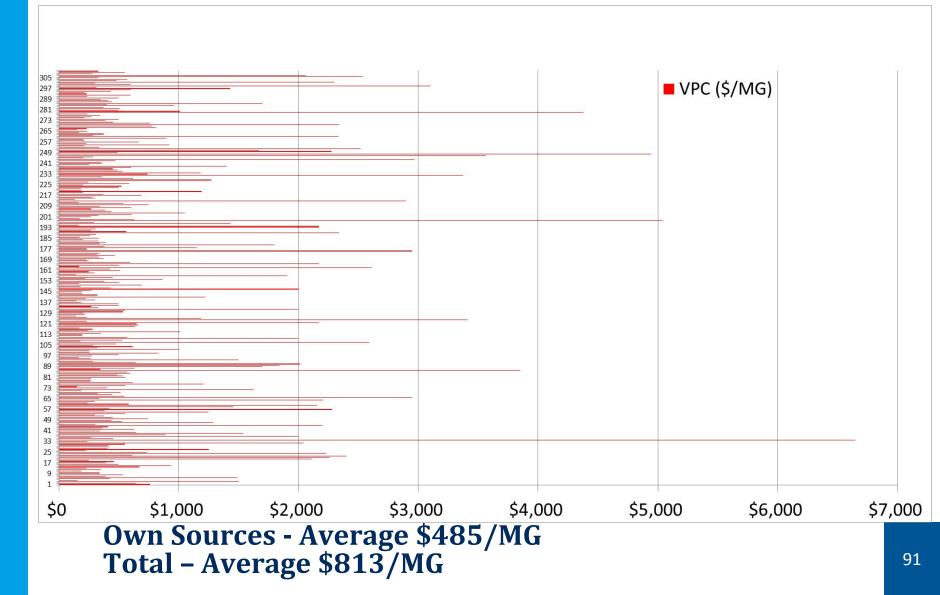


Customer retail unit cost (applied to Apparent Losses)



Water Loss Benchmarks

VARIABLE PRODUCTION COST



DATA SUMMARY (JUNE 2013)

Key Performance Indicator	n	AVG
Data Validity Score	310	62.5
Non-Revenue Water as % by Volume	310	23.1%
Non-Revenue Water as % by Cost	310	9.1%
Apparent Loss (gal/connection/day)	310	11.2
Real Loss (gal/connection/day)	248	56.5
Real Loss (gal/mile of main/day)	62	1,932
Infrastructure Leakage Index	283	3.0

NATIONAL DATA INITIATIVE ACKNOWLEDGEMENTS

Water Audit Software Subcommittee (WASS) Members: WLCC Chair: John Van Arsdel, M.E. Simpson Company, Inc. WASS Chair: Andrew Chastain-Howley, Black & Veatch George Kunkel, Philadelphia Water Department Will Jernigan, Cavanaugh & Associates, P.A. Alain Lalonde, Veritec Consulting Inc. Ralph McCord, Louisville Water Company David Sayers, Delaware River Basin Commission Brian Skeens, CH2M HILL Isabel Szendry, Puerto Rico ASA

