Water Loss Technical Assistance Program

Wave 3 Work Session
New Learner Track

Today's Agenda

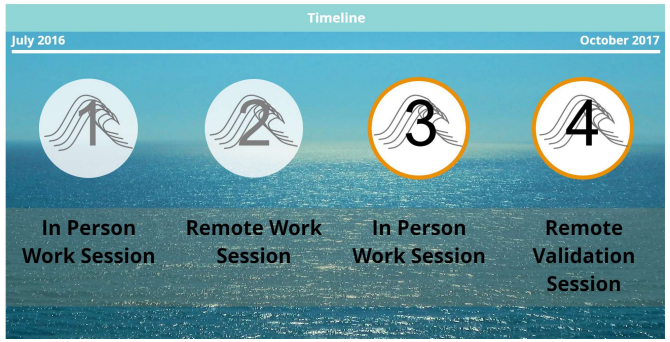
- Water Audit Reminders
- Wave 2 Debrief
- Wave 4 Preparation:
  - Supporting Documentation
  - DVG Standardization
  - Example Calculations
  - Logistics!
- Next Steps in Water Auditing
- Immediate Next Step Planning

WAVE 3

1 2 3 4

March 2017 - May 2017

Water Loss TAP



Water Audit Reminders

why work on water loss?

save water reduce costs

(comply with regulations!)

water audits

- understand your loss volumes and costs
- identify savings opportunities
- build credibility with stakeholders

water loss reduction

- conserve water
- improve revenue
- lessen liability

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Water Audit Reminders

the water balance

SYSTEM INPUT VOLUME	AUTHORIZED CONSUMPTION	BILLED AUTHORIZED CONSUMPTION	BILLED METERED CONSUMPTION	REVENUE WATER
			BILLED UNMETERED CONSUMPTION	
		UNBILLED AUTHORIZED CONSUMPTION	UNBILLED METERED CONSUMPTION	$ $ $ NONREVENUE WATER
			UNBILLED UNMETERED CONSUMPTION	
	WATER LOSSES	$ $ $ APPARENT LOSSES $ $ $	CUSTOMER METER INACCURACIES	
			UNAUTHORIZED CONSUMPTION	
			DATA HANDLING ERRORS	
		REAL LOSSES		

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Water Audit Reminders

Separate total Water Loss into Real and Apparent Losses

Apparent Losses

Real Losses

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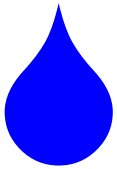
Water Audit Reminders

Use metrics in units of values, volumes, and validity.



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Data Validity Guidance

	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

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Wave 2 Debrief

HANDOUT!

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Wave 2 Debrief

Share Your Experience?

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Wave 2 Debrief

Observed Trends	Audit Impacts
• Water Audits are familiar (UWMPs, early adopters)	→ • Opportunities for refining audit inputs and institutionalizing audit practices
• Production meter accuracy testing is not standard *electronic calibration is much more commonly practiced*	→ • Uncertainty around accuracy of Water Supplied volumes
• Customer meter testing programs focus on targeted groups (large meters, old meters)	→ • Apparent Losses are estimated, reducing confidence in Real Loss estimation
• Incomplete Supporting Documentation	→ • Level 1 Validation process and grading limits

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Wave 4 Preparation

May 2017 - September 2017

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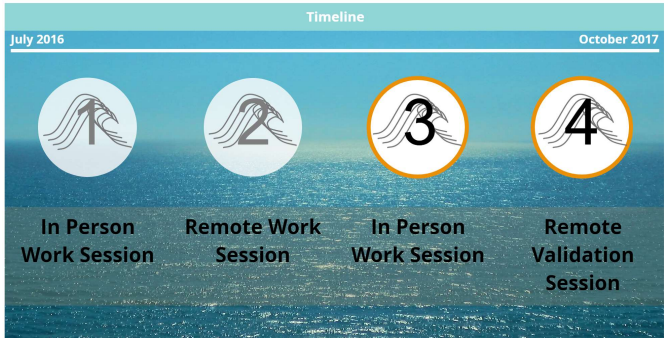
Water Loss TAP



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Data Quality and Validation

- ***Data quality*** – the validity, or trustworthiness, of the data
- ***Data validation*** – a quality control process conducted to verify, and improve as needed, the data inputs and gradings of the water audits submitted by water utilities.
- ***Water Loss Audit validation*** – does not make data inputs or gradings "right" or "wrong", but merely aligns them with the actual conditions that occurred in the operation of the utility for the audit year
  - Level 1 -- Top down Data Review
  - Level 2 -- Top down Data Mining Review
  - Level 3 -- Bottom up Field Investigation

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Wave 4 Validation Session

Purpose of Level 1 Validation

1) review of audit methodology and volume determination
2) review of Data Validity Grade selection

goals: quality and consistency

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2016 UWMP Submitted Data - Unfiltered

	STATISTIC	2016 n = 292 min	2016 n = 292 median	2016 n = 292 max	UNIT
financial	Customer Retail Unit Cost	$0.00	$3.93	$180,097.61	$ / 1,000 gal
	Variable Production Cost	$0.00	$1,315.45	$25,007,000.00	$ / million gal
	NRW as % of Operating Cost	0.00%	3.54%	242305%	% of operating cost
volumetric	Apparent Losses	-4.34	6.36	122.3	gal/ serv conn / day
	Real Losses (serv conns)	-35	19.46	334.54	gal/ serv conn / day
	Real Losses (pressure)	-0.66	0.371	5.31	gal/ serv conn / day / psi
	ILI	-3.03	1.18	17.84	CARL / UARL
	Data Validity Score	2.35	75.33	98.27	points out of 100

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Wave 4 Validation Session

Purpose of Level 1 Validation

1) review of audit methodology and volume determination
2) review of Data Validity Grade selection

Level 1 Validation Tools:

- Discussion with Audit Team (Wave 4 Validation Session)
- SUPPORTING DOCUMENTATION

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Supporting Documentation

provides more detail on key values

Goal: show the source data and/or derivations used to get audit input

When compiling supporting documents, remember!

- excel spreadsheets, text files preferred over PDFs for tabular data
- include notes on any exceptions, corrections, or data gymnastics included in your audit input calculation

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Supporting Documentation

provides more detail on key values

REQUIRED	SUPPLEMENTAL
❑ Volume from Own Sources *broken down by month and meter*	❑ Customer Meter Inaccuracy derivation
❑ Water Imported *broken down by month and meter*	❑ Average Operating Pressure derivation
❑ Water Exported *broken down by month and meter*	❑ Customer Retail Unit Cost derivation
❑ Supply Meter Testing	❑ Variable Production Cost derivation
❑ Volume of Metered Consumption *broken down by month and charge code*	❑ System Schematic *showing locations of Supply and Export Meters*

Required Supporting Documents are critical for Level 1 Validation

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Supporting Documentation

EXAMPLES!

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Example Audit Calculations

Data Matrix Standardization

Selecting A DVG

determine the **highest grade** where the utility **meets or exceeds all** criteria for that grade and all grades below it

Common questions

Navigating any subjective words

Dealing with unique scenarios

Grade Focus

Those data grades dealing with the largest volumes carry the most weight in the DVS, and the reliability of the audit

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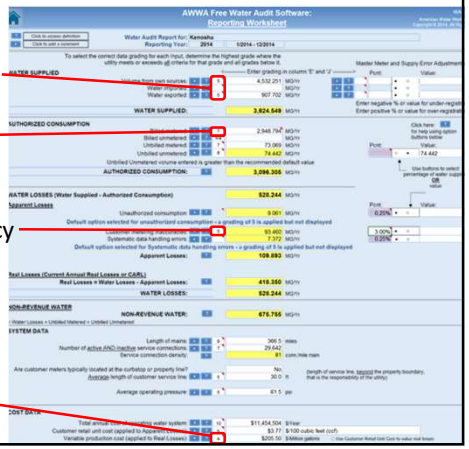
Grade Focus

Volume from own sources
Water imported/exported

Billed metered AC

Customer meter inaccuracy

Variable production cost



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Grade Focus

WATER AUDIT DATA VALIDITY SCORE:

*** YOUR SCORE IS: 58 out of 100 ***

A weighted scale for the components of consumption and water loss is included in the calculation of the Water Audit Data Validity Score

PRIORITY AREAS FOR ATTENTION:

Based on the information provided, audit accuracy can be improved by addressing the following components:

1: Volume from own sources
2: Variable production cost (applied to Real Losses)
3: Customer metering inaccuracies

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VOLUME FROM OWN SOURCES – DVG CRITERIA	ADDITIONAL GUIDANCE
1. Less than 25% of water production sources are metered, remaining sources are estimated. No regular meter accuracy testing or electronic calibration conducted.	
2. 25% - 50% of treated water production sources are metered; other sources estimated. No regular meter accuracy testing or electronic calibration conducted.	Manufacturer testing certificate for newly installed meter does not qualify as accuracy testing
4. 50% - 75% of treated water production sources are metered, other sources estimated. Occasional meter accuracy testing or electronic calibration conducted.	% of source metric is for volume, not meter count Occasional = within last 5 years but less than annually, for <90% of source flow
6. At least 75% of treated water production sources are metered, or at least 90% of the source flow is derived from metered sources. Meter accuracy testing and/or electronic calibration of related instrumentation is conducted annually. Less than 25% of tested meters are found outside of +/- 6% accuracy.	Accuracy testing = precise & independent volumetric measurement in-situ against subject meter for at least 90% of the source flow by volume OR Calibration = alignment of flow range conversion with signal span output (4-20) and SCADA output
8. 100% of treated water production sources are metered, meter accuracy testing and electronic calibration of related instrumentation is conducted annually, less than 10% of meters are found outside of +/- 6% accuracy	Must have both accuracy testing AND calibration for 90% of the source flow
10. 100% of treated water production sources are metered, meter accuracy testing and electronic calibration of related instrumentation is conducted semi-annually, with less than 10% found outside of +/- 3% accuracy. Procedures are reviewed by a third party knowledgeable in the M36 methodology.	3rd party M36 review = testing and calibration practices have been closely scrutinized for compliance with procedures described in the M36 Manual Must have both accuracy testing AND calibration for 90% of the source flow

WATER IMPORTED - DVG CRITERIA	ADDITIONAL GUIDANCE
1. Less than 25% of imported water sources are metered, remaining sources are estimated. No regular meter accuracy testing.	
2. 25% - 50% of imported water sources are metered; other sources estimated. No regular meter accuracy testing.	Manufacturer testing certificate for newly installed meter does not qualify as accuracy testing
4. 50% - 75% of imported water sources are metered, other sources estimated. Occasional meter accuracy testing conducted.	% of source metric is for volume, not meter count Occasional = within last 5 years but less than annually, for <90% of source flow
6. At least 75% of imported water sources are metered, meter accuracy testing and/or electronic calibration of related instrumentation is conducted annually for all meter installations. Less than 25% of tested meters are found outside of +/- 6% accuracy.	Accuracy testing = precise & independent volumetric measurement in-situ against subject meter for at least 90% of the source flow by volume OR Calibration = alignment of flow range conversion with signal span output (4-20) and SCADA output
8. 100% of imported water sources are metered, meter accuracy testing and electronic calibration of related instrumentation is conducted annually, less than 10% of meters are found outside of +/- 6% accuracy.	Must have both accuracy testing AND calibration for 90% of the source flow
10. 100% of imported water sources are metered, meter accuracy testing and electronic calibration of related instrumentation is conducted semi-annually for all meter installations, with less than 10% of accuracy tests found outside of +/- 3% accuracy.	Must have both accuracy testing AND calibration for 90% of the source flow

BILLED METERED – DVG CRITERIA	ADDITIONAL GUIDANCE
4. At least 75% of customers are metered……only very limited meter accuracy testing is conducted. Customer meters are replaced only upon complete failure. Computerized billing records exist, but only sporadic internal auditing conducted.	Very limited testing (reactionary) = complaint based or consumption flag testing only Sporadic = less than annual
6. At least 90% of customers are metered……only limited meter accuracy testing is conducted. Regular replacement is conducted for the oldest meters. Computerized billing records exist with annual auditing of summary statistics conducting by utility personnel.	Limited testing (proactive) = more than reactive testing (per DVG of 4), targeted to certain subsets but not representative sampling of full meter population Summary statistics = total volumes year to year
8. At least 97% of customers are metered……regular meter accuracy testing guides replacement of statistically significant number of meters each year. Routine auditing of computerized billing records for global and detailed statistics occurs annually by utility personnel, and is verified by third party at least once every five years.	Regular testing (proactive) = testing certain subsets but not representative sampling of full meter population, with the results directly utilized to dictate maintenance and replacement activities Detailed statistics = at least down to the charge code level, Third party audit = sampling review on select accounts If presently in a meter changeout or conversion project, OK to treat new meter installations as 'testing' for audit year installed +1 year (2-year horizon)
10. At least 99% of customers are metered……statistically significant customer meter testing and replacement program in place on a continuous basis. Computerized billing with routine, detailed auditing, including field investigation of representative sample of accounts undertaken annually by utility personnel. Audit is conducted by third party auditors at least once every three years.	Statistically significant testing and replacement = proactive large meter testing targeted based on revenue and small meter testing based on random representative sampling, results directly utilized to dictate maintenance and replacement activities Third party audit = full billing database query and analysis of raw data to rebuild to the summary consumption volumes

CUSTOMER METERING INACCURACY	ADDITIONAL GUIDANCE
2. …Customer meters are tested for accuracy only upon customer request.	Input is an estimate, not calculated.
4. …Meter accuracy testing is conducted annually for a small number of meters (more than just customer requests, but less than 1% of inventory). A limited number of the oldest meters are replaced each year. Inaccuracy volume is largely an estimate, but refined based upon limited testing data.	Limited replacement = replaced if failed Volume *inferred* for full meter population but informed only from reactive test data, such as complaint tests or consumption flagged tests
6. …Routine, but limited, meter accuracy testing and replacement occur. Inaccuracy volume is quantified using a mix of reliable and less certain data.	Routine = proactive Volume *calculated* for full meter population based on proactive test data but less than representative sampling
8. Ongoing meter replacement and accuracy testing result in highly accurate customer meter population. Testing is conducted on samples of meters of varying age and accumulated volume of throughput to determine optimum replacement time for various types of meters.	Ongoing = annual Volume *calculated* for full meter population based on proactive test data from representative sampling
9. Ongoing meter replacement and accuracy testing result in highly accurate customer meter population. Statistically significant number of meters are tested in audit year. This testing is conducted on samples of meters of varying age and accumulated volume of throughput to determine optimum replacement time for these meters.	Statistical significance = testing program margins of error have been analyzed
10. …Ongoing meter replacement occurs according to a targeted and justified basis. Regular meter accuracy testing gives a reliable measure of composite inaccuracy volume for the customer meter population. New metering technology is embraced to keep overall accuracy improving. Procedures are reviewed by a third party knowledgeable in the M36 methodology.	Targeted and justified = proactive large meter testing targeted based on revenue and small meter testing based on random representative sampling, results directly utilized to dictate maintenance and replacement activities 3rd party M36 review = testing program and input calculations have been closely scrutinized for compliance with procedures described in the M36 Manual by third party

VARIABLE PRODUCTION COST – DVG CRITERIA	ADDITIONAL GUIDANCE
4. … Electric power and treatment costs are reliably tracked and allow accurate weighted calculation of unit variable production costs based on these two inputs and water imported purchase costs (if applicable). …	If only primary costs included, DVG of 4 (power, chemicals and/or purchase water costs)
6. …Pertinent additional costs beyond power, treatment and water imported purchase costs (if applicable) such as liability, residuals management, wear and tear on equipment, impending expansion of supply, are included in the unit variable production cost, as applicable. All costs audited internally on an annual basis.	*Some but not all* secondary costs have been evaluated and incorporated including but not limited to damages paid from claims from line breaks, wear and tear on dynamic equipment, residuals management and impending expansion of supply. If some of the secondary costs are not applicable, the *basis* for this should be documented.
8. ….all pertinent primary and secondary variable production and water imported purchase (if applicable) costs tracked. The data is audited at least annually by utility personnel, and at least once every three years by a third-party knowledgeable in the M36 methodology.	*All* secondary costs have been evaluated and incorporated as applicable. For any deemed not applicable, the *basis* for this should be documented. 3rd party M36 review = input calculations have been reviewed by a water loss expert
10. Either…. 1) Third party CPA audit of all pertinent primary and secondary variable production and water imported purchase (if applicable) costs on an annual basis, or: 2) Water supply is entirely purchased as bulk water imported, and the unit purchase cost - including all applicable marginal supply costs - serves as the variable production cost. If all applicable marginal supply costs are not included in this figure, a grade of 10 should not be selected.	*All* secondary costs have been evaluated and incorporated as applicable. For any deemed not applicable, the *basis* for this should be documented. 3rd party M36 review = input calculations have been reviewed by a water loss expert

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Wave 4 Sequence

Schedule your team's call

Complete & upload your audit
(CY or FY) and SDs

Wave 4 call

Get final validation document from PM Team

Submit Level 1 validated water audit package to DWR

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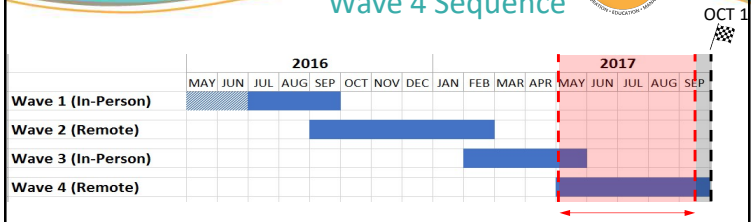
Wave 4 Sequence



Schedule your team's call
Dates between 5/1/17 and 9/15/17

Complete & upload your audit and SDs

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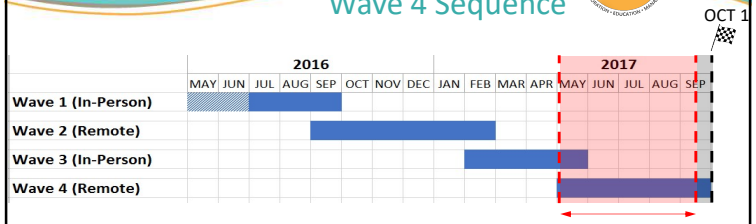

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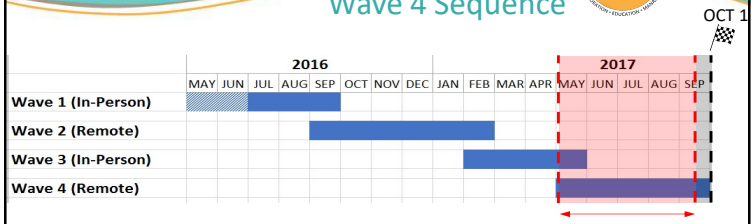

Calendar or Fiscal? Things to consider.

1) Time needed to gather complete audit data, compile audit & SDs, do validation call, follows ups as needed, and submit to DWR.
2) Bi-monthly billing and window for data availability
3) Proximity of audit results to coming budget/planning cycle
4) Reporting timeframe for other reports you submit
5) Effects of *not* prorating BMAC when CY vs FY

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Supporting Documents

REQUIRED	SUPPLEMENTAL
❑ Volume from Own Sources *broken down by month and meter*	❑ Customer Meter Inaccuracy derivation
❑ Water Imported *broken down by month and meter*	❑ Average Operating Pressure derivation
❑ Water Exported *broken down by month and meter*	❑ Customer Retail Unit Cost derivation
❑ Supply Meter Testing	❑ Variable Production Cost derivation
❑ Volume of Water Sold *broken down by month and charge code*	❑ System Schematic *showing locations of Supply and Export Meters*

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Changes from Wave 2 audit to Wave 4 audit?

More or less availability of information and supporting documents

Changed understanding from utility staff and their articulation of answers to the interview questions

Changed practices from wave 2 to wave 4

Additional guidance on DVG

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WAVE 4

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May 2017 - September 2017

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WAVE 4

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ANNUAL FALL CONFERENCE
OCTOBER 23-26, 2017
Atlantis Casino Resort
Reno, NV
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Wave 3 Workshop

LUNCH!

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Next Steps in Water Auditing

Interpreting Water Audit Results

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Interpreting Results

- ✓ Complete Water Audit
- ✓ Supporting Documentation Compiled
- ✓ Level 1 Validation

informed next steps on water loss assessment and intervention

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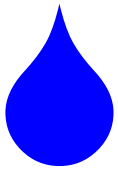
Water Audit Results

volumes values validity



next steps must take all of these insights into account

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Critical Questions

1) Where are the biggest uncertainties in my water audit? How do they impact my results? → *Priority Areas for Data Improvement*

2) What does my water audit tell me, even given those uncertainties? → *Potential for Water Loss Control*

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Critical Questions

1) Where are the biggest uncertainties in my water audit? How do they impact my results?

Consider:

- Data Validity Grades and Criteria as a guide
- Audit Team Deliberation!
  remember: DVGs do not describe accuracy

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Critical Questions

2) What does my water audit tell me, even given uncertainties?

Consider:

- Volumetric Performance Indicators
- Costs of Losses

are there immediate opportunities for savings?

how do these volumes and costs compare to other utility activity?

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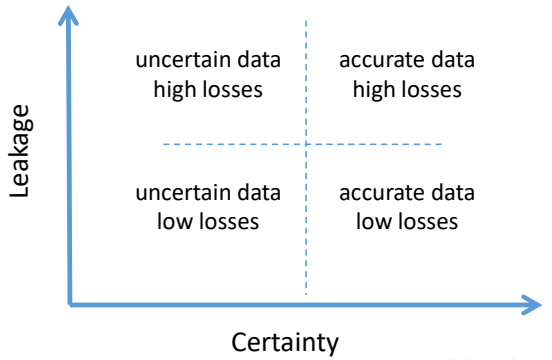
Axes of Water Loss Control



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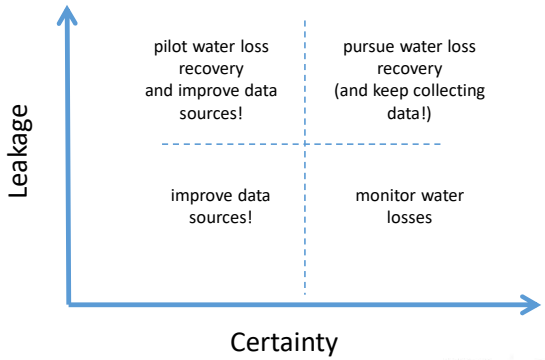
Axes of Water Loss Control



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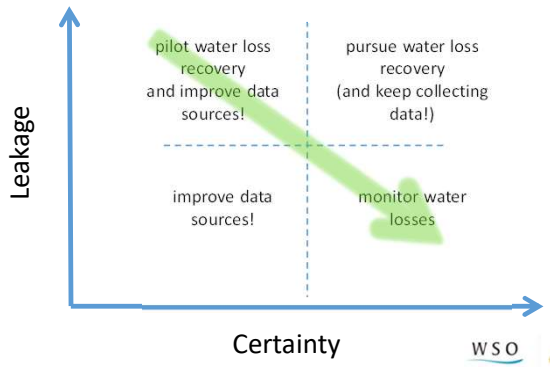
Axes of Water Loss Control

how do costs of leakage shift your position?



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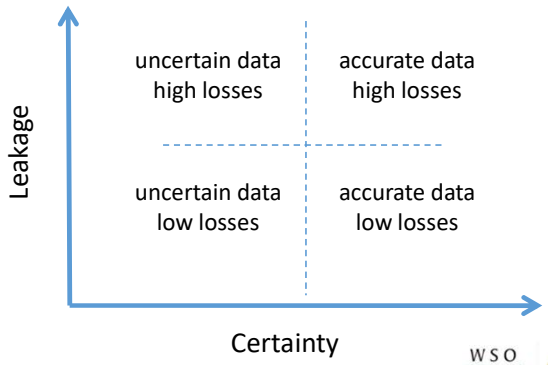
Axes of Water Loss Control

where does your utility stand now?



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Next Steps in Water Auditing

Supply Meter Testing

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Supply Metering

High flowrate applications

Venturi, Orifice, Magnetic, Ultrasonic

Medium, low flowrate applications

Turbine, Propeller, Positive Displacement

36-inch Venturi Meter
(Source: Primary Flow Control)

60-inch magnetic flowmeter being installed in Philadelphia, PA

Insertion magnetic flowmeter in use on a 30-in. pipeline in Birmingham, Al

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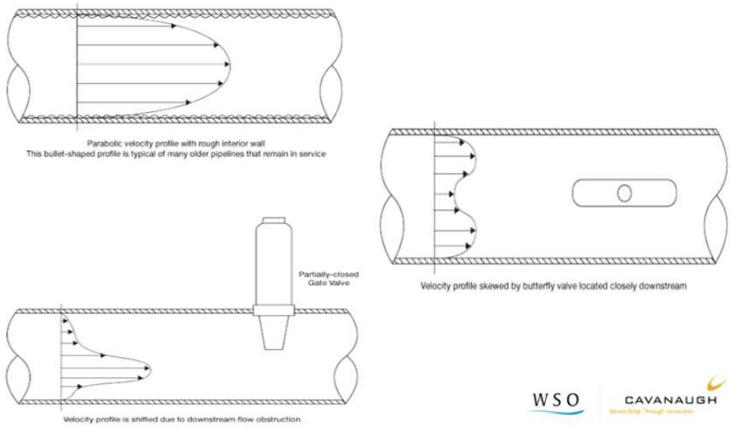
Basic Pipeline Hydraulics

(Source AWWA M36 Publication, 4th Ed.)



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Proper Meter Siting

Flowmeter Type	Recommended Lengths of Straight Pipe* (stated in terms of number of upstream pipe diameters for the given metering application)
Venturi	4–10 diameters—depending on the type of any flow-disturbing obstruction in the pipeline
Orifice	5 diameters
Flow tube	4–10 diameters—depending on the type of any flow-disturbing obstruction in the pipeline
Pitot tube	10 diameters
Propeller	5 diameters
Turbine	25 to 30 diameters
Turbine (with flow-straightening element)	10 diameters
Magnetic	5 diameters
Ultrasonic (Doppler shift)	7–10 diameters
Ultrasonic (pulse transmission†)	7–10 diameters (and 5 diameters downstream)

*Information is based on engineering judgment and conservative best practice observed in the water industry by AWWA Water Loss Control Committee members (Source: AWWA M36 Publication, 4th Ed.)

†Includes transit time flowmeters

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Proper Meter Siting

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Proper Meter Siting

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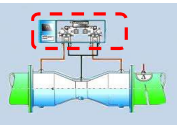
What Constitutes a Meter?

Primary Device: Measuring Element

Conducts the measurement

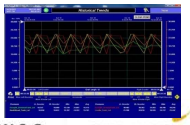
Secondary Device: Register, Transmitter

Converts, communicates the measurement



Tertiary Device: Remote Database

Records, archives the measurement



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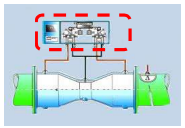
Accuracy Testing v. Calibration

Primary Device: Accuracy Testing

Independent measurement for comparison

Secondary Device: Calibration

Checks alignment of primary measurement to register and signal output



Tertiary Device: Calibration

Checks alignment of secondary signal to SCADA output

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Supply Meter Testing

Insertion type

Clamp-on

Comparative apparatus

Volumetric displacement

Factory bench test

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Supply Meter Testing

Insertion type

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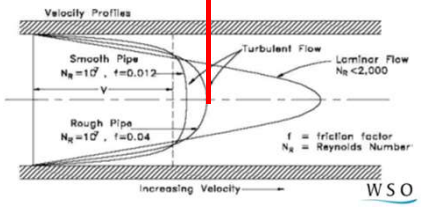
Supply Meter Testing

Insertion type



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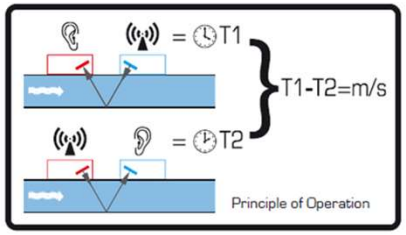
Supply Meter Testing

Clamp-on



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Clamp-on (ultrasonic)

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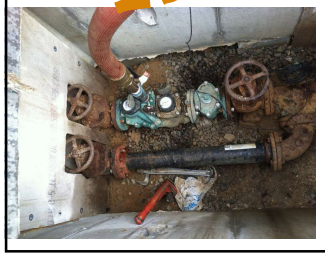
Comparative apparatus



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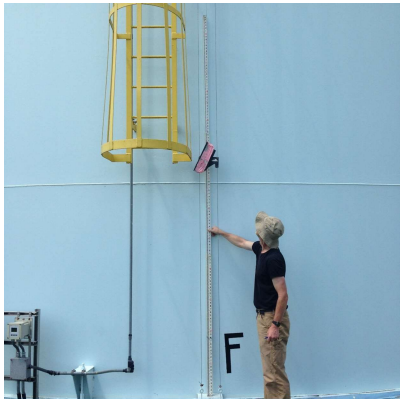
Volumetric displacement



Reservoir or clearwell adjacent to a water treatment plant

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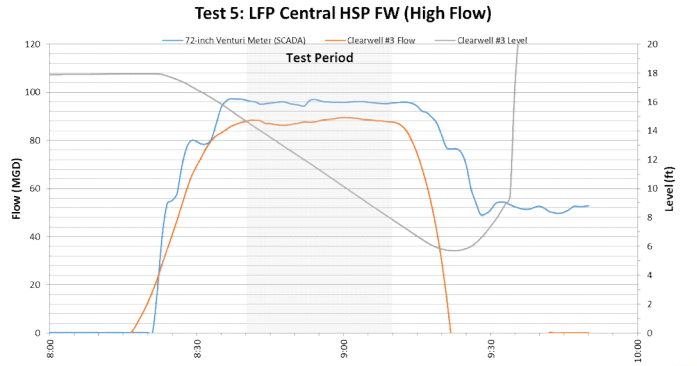
Drawdown Test



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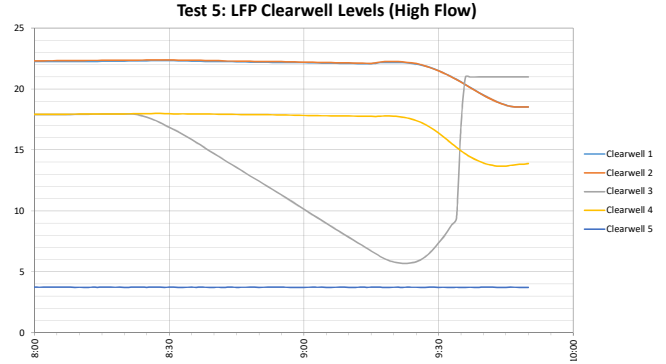
Clearwell Levels During Test



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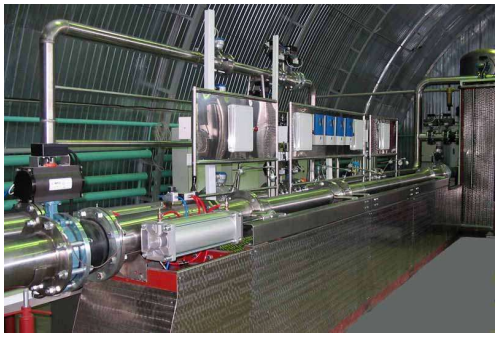
Factory bench test



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Factory bench test

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Supply Meter Testing

Other considerations

- Flow rates
- Test location (if insertion or clamp-on)
- Test duration

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Summary

Method	Advantages	Limitations
Insertion type 	Minimize the unknowns by verifying the flow condition and inside area of the pipe, can make this a very reliable method No interruption to operations	Requires a good test site! Lower test flowrates can affect uncertainty Specialized equipment and expertise required
Clamp-on 	Easier to do, no tap required No interruption to operations	Requires a good test site! Signal distortion depending on pipe material can affect accuracy, and there's no verification of flow conditions via flow profile or of inner diameter
Comparative apparatus 	More control over the flow condition and the test reliability	Typically only practical for smaller line applications Supply is interrupted during test
Volumetric displacement 	Can be reliable method Potentially done internally and frequently	Requires a reservoir nearby, reliable field verification of reservoir geometry, including internal components (baffles etc) and all associated plumbing/valves Level sensing must be calibrated and reliable Production is typically interrupted during test
Factory bench test 	Get to test it under ideal conditions	Only tested under ideal conditions! Not practical for larger meters Meter is out of service for test

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Next Steps in Water Auditing

Customer Meter Testing Programs

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Understanding Water Losses

WATER SUPPLIED	AUTHORIZED CONSUMPTION	BILLED AUTHORIZED CONSUMPTION	BILLED METERED CONSUMPTION	REVENUE WATER
			BILLED UNMETERED CONSUMPTION	
		UNBILLED AUTHORIZED CONSUMPTION	UNBILLED METERED CONSUMPTION	$ $ $
			UNBILLED UNMETERED CONSUMPTION	
	WATER LOSSES	$ $ $ APPARENT LOSSES $ $ $	CUSTOMER METER INACCURACIES	NONREVENUE WATER
			UNAUTHORIZED CONSUMPTION	
			DATA HANDLING ERRORS	
		REAL LOSSES		

Total Water Loss Volume … What's Next?

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Understanding Water Losses

TOTAL WATER LOSS

Apparent Losses

Real Losses

we start with estimation of Apparent Loss

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Goals of Meter Testing in Water Loss Control

- Study accuracy of the meter stock
- Calculate an Apparent Loss volume* due to metering inaccuracy
- Inform proactive management of meter stock's accuracy

in the Water Balance, our understanding of Apparent Losses directly impacts our understanding of Real Losses

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Small Meter Testing Programs

1. Design Meter Test Sample
2. Test Meters
3. Analyze & Apply Results

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Small Meter Testing Programs

1 Design Meter Test Sample

- Representative and random meter sample → *remember our goal is to appreciate the accuracy of the **whole population***
- What sample size is big enough?

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Small Meter Testing Programs

2 Test Meters

- Careful with meter transport
- Test at low, medium, and high flows
- Document thoroughly
  - include reference volume, testing flow rate, meter totalizer reads, all meter information
  - compile data in analysis-friendly format

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Small Meter Testing Program

3 Analyze & Apply Test Results

- Organize all test results
- Analyze accuracy findings *
- Consider confidence limits
- Calculate Apparent Loss Volumes

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Small Meter Testing Program

3 Analyze & Apply Test Results

Accuracy Results Analysis Considerations

- Averaging across flow rate results
  - time-weighting
  - volume-weighting and consumption profiling
- Handling stuck meters

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Analyzing Results
example

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	98.5%	0.4%
1"	2,145	20	96.9%	2.3%
1-1/2"	311	5	94.0%	3.8%
2"	391	13	97.6%	1.7%

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Analyzing Results
example

Calculating Apparent Losses:
what are the volumetric impacts of inaccuracy?

Meter Size	Volume Recorded During Audit (MG)	Volume-Weighted Average Accuracy	Apparent Losses During Audit (MG)
5/8"	691.53	92.0%	60.13
3/4"	94.10	98.5%	1.43
1"	314.74	96.9%	10.07
1-1/2"	133.96	94.0%	8.55
2"	295.89	97.6%	7.28

the more consumption, the more important accuracy!

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Small Meter Testing Takeaways

- Value of random sampling
- Average across different flow rate results
- Add layer of consumption to calculate Apparent Losses due to meter inaccuracy

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- Appreciate spread of results, confidence limits
- Tread carefully re: correlations
- Continue to test for more insight

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Large Meter Testing

- Fewer, more important meters!
- Individual assessment
- Prioritize by consumption
- Flow profiling is key

1. Design Meter Test Sample
2. Test Meters
3. Analyze & Apply Results

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Next Steps!

May 2017 - September 2017

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Wave 4 Sequence

Schedule your team's call

Complete & upload your audit (CY or FY) and SDs
Reminder: Download a fresh v5.0 of the audit software to compile your Wave 4 audit at www.awwa.org/waterlosscontrol

Wave 4 call

Get final validation document from PM Team

Submit Level 1 validated water audit package to DWR

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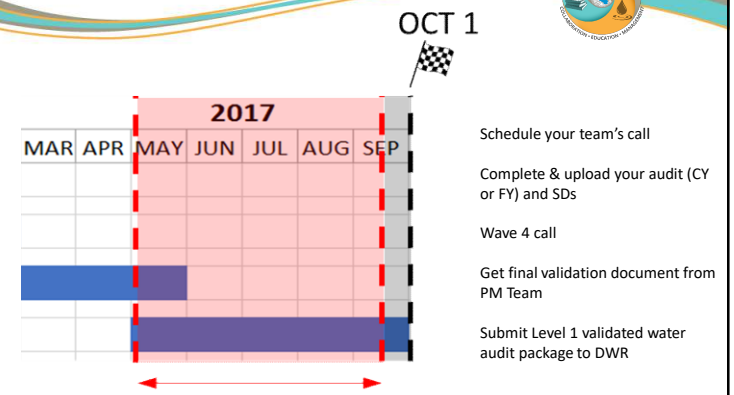

Wave 4 Sequence

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Wave 4 Sequence

Schedule your team's call

When will the audit & docs be complete?

Complete & upload your audit and SDs

When will your team meet to prep for the call?

Wave 4 call + any actions from the session

When will your team meet post-call for any actions needed?

Get final validation document from PM Team

Submit Level 1 validated water audit package to DWR

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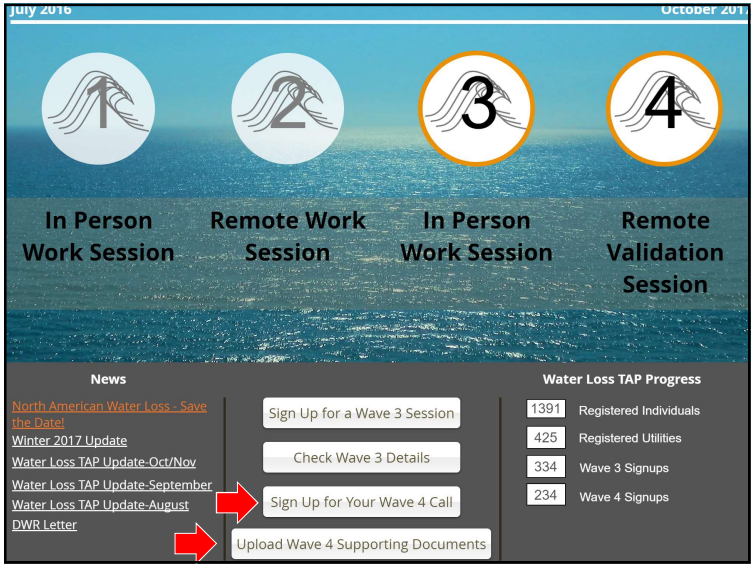

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WAVE 4

www.northamericanwaterloss.org

ANNUAL FALL CONFERENCE
OCTOBER 23-26, 2017
Atlantis Casino Resort
Reno, NV
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Thank You!

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